5-6115-458-34

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| AIR FORCE | T.O. 35C2-3-443-2 |
| ARMY | TM5-6115-458-34 |
| NAVY | NAVFAC-P-8-629-34 |
| MARINE CORPS | TM-07536A-35 |

This copy is a reprint which includes current pages from Changes 1 through 6.

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TECHNICAL MANUAL

INTERMEDIATE (FIELD)
(DIRECT AND GENERAL SUPPORT)
AND DEPOT LEVEL MAINTENANCE

# GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL

## SKID MTD., 200 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

| DOD MODELS | CLASS | HERTZ | FSN |
|---|---|---|---|
| MEP009A | UTILITY | 50/60 | 6115-133-9104 |
| MEP108A | PRECISE | 50/60 | 6115-935-8729 |

## INCLUDING OPTIONAL KITS

| DOD MODELS | NOMENCLATURE | FSN |
|---|---|---|
| MEP009AWF | WINTERIZATION KIT, FUEL BURNING | 6115-403-3761 |
| MEP009AWE | WINTERIZATION KIT, ELECTRIC | 6115-489-7285 |
| MEP009ALM | DUMMY LOAD KIT | 6115-403-3762 |

Consolidated Diesel Electric Company
Contract Number F04606-70-D-0192

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Published under authority of the
Departments of the Air Force, the Army, and the Navy
(Including U.S. Marine Corps)

.D 101.11:

15 JAN 1974

## WARNING

All specific cautions and warnings contained in this manual shall be strictly adhered to. Otherwise, severe injury, death and/or damage to the equipment may result.

### HIGH VOLTAGE

is produced when this generator set is in operation.

### DEATH

or severe burns may result if personnel fail to observe safety precautions. Do not operate this generator set until the ground terminal stud has been connected to a suitable ground. Disconnect the battery ground cable before removing and installing components on the engine or in the electrical control panel system.

Do not attempt to service or otherwise make any adjustments, connections or reconnections of wires or cables until generator set is shut-down and completely de-energized.

### DANGEROUS GASES

Batteries generate explosive gas during charging; therefore, utilize extreme caution, do not smoke, or use open flame in vicinity when servicing batteries.

Exhaust discharge contains noxious and deadly fumes. Do not operate generator sets in inclosed areas unless exhaust discharge is properly vented to the outside.

### DANGEROUS GASES (Cont)

When filling fuel tank, maintain metal to metal contact between filler nozzle and fuel tank. Do not smoke or use an open flame in the vicinity.

Use extreme care, should a selenium rectifier malfunction, to avoid inhalation of poisonous fumes.

### LIQUIDS UNDER PRESSURE

are generated as a result of operation of the generator set. Do not expose any part of the body to a high pressure leak in the fuel or hydraulic system of the generator set.

Relieve pressure from radiator before removing radiator cap.

### NOISE

operating level of this generator can cause hearing damage. Ear protectors, as recommended by the medical or safety officer, must be worn when working near this set.

## CAUTION

### DAMAGE

to the equipment may result if personnel fail to observe the cautions contained in this manual.

If generator set is shut-down by the operation of a safety device, do not attempt to operate the unit until the cause has been determined and eliminated.

| | |
|---|---|
| DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER | T.O. 35C2-3-443-2 |
| DEPARTMENT OF THE ARMY TECHNICAL MANUAL | TM5-6115-458-34 |
| DEPARTMENT OF THE NAVY PUBLICATION | NAVFAC-P-8-629-34 |
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HEADQUARTERS
DEPARTMENTS OF THE ARMY, AIR FORCE, NAVY, & USMC
WASHINGTON, D.C., 20 OCTOBER 1977

# INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT LEVEL MAINTENANCE

# GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL, SKID MTD., 200 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

| DOD MODELS | CLASS | HERTZ | NSN |
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| MEP009A | UTILITY | 50/60 | 6115-00-133-9104 |
| MEP108A | PRECISE | 50/60 | 6115-00-935-8729 |

## INCLUDING OPTIONAL KITS

| DOD MODELS | NOMENCLATURE | NSN |
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| MEP009AWF | WINTERIZATION KIT, FUEL BURNING | 6115-00-403-3761 |
| MEP009AWE | WINTERIZATION KIT, ELECTRIC | 6115-00-489-7285 |
| MEP009ALM | DUMMY LOAD KIT | 6115-00-403-3762 |

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Current as of 27 February 1979

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## SAFETY PRECAUTIONS

### BEFORE OPERATION

Do not operate the generator set in an enclosed area unless the exhaust gases are piped to the outside. Inhalation of exhaust fumes may result in death or serious illness.

Do not smoke or use an open flame in the vicinity of batteries when servicing. Batteries generate hydrogen, a highly explosive gas. When removing batteries, remove both negative cables before removing positive cables.

Do not operate the generator set unless the ground terminal stud has been connected to a suitable ground. Electrical faults in the generator set, load lines, or load equipment can cause death by electrocution from contact with an ungrounded system.

When filling fuel tank, always provide metal-to-metal contact between container nozzle and fuel tank to prevent sparks from static electricity.

Do not use a lifting device with a capacity of less than 15,000 pounds. Do not allow the generator set to swing while it is suspended. Failure to observe this warning may result in death or serious injury to personnel.

Before making connections for parallel operation, make sure the generator sets are not operating and that all switches are off. Electrical faults in the generator set, load lines, and load equipment can cause death by electrocution.

### DURING OPERATION

Do not attempt to change a load connection or perform maintenance on the generator set while it is in operation. Always make sure generator set is not connected to an energized line before performing maintenance. The power generated by this equipment can cause death by electrocution. Under no circumstance should any person service, adjust or perform maintenance on high voltage equipment without the presence of someone who is capable of rendering aid.

### AFTER OPERATION

Do not smoke or use an open flame in the vicinity of batteries when servicing. Batteries generate hydrogen, a highly explosive gas.

Do not allow the generator set to swing while it is suspended. Failure to observe this warning may result in death or serious injury to personnel.

If radiator cap must be removed while coolant is hot, then remove slowly with caution as hot coolant may escape causing severe burns.

# CHAPTER 1

# INTRODUCTION

## Section I. GENERAL

### 1-1. SCOPE.

a. This manual contains instructions for the use of intermediate (field) (direct and general support) and depot maintenance personnel maintaining the 200 KW Diesel Engine Generator Set, Models MEP009A and MEP108A. It provides information on the maintenance of equipment which is beyond the scope of the tools, equipment, personnel, or supplies normally available to operator and organizational level of maintenance. This manual is to be used in conjunction with the Operator and Organizational Maintenance Manual.

b. THIS TECHNICAL MANUAL IS USED BY THE ARMY, AIR FORCE, NAVY, AND MARINE CORPS. THE USE OF FORMS AND COMPLIANCE WITH DIRECTIVES AS STATED HEREIN WILL BE ACCOMPLISHED ONLY BY PERSONNEL OF THE SERVICE TO WHICH THEY APPLY.

### 1-2. FORMS AND RECORDS.

a. Forms and Records used by the Army will be only those prescribed by TM38-750. Those used by the Marine Corps will be those prescribed by TM4700-15/1. Other service users should refer to appropriate specifications/publications for equipment maintenance forms and records.

b. Report of errors, omissions, and recommendations for improvement of this publication by the individual users is encouraged. Reports should be submitted as follows:

1. Air Force - AFTO Form 22 in accordance with T.O. 00-5-1 and direct to Commander, Sacramento Air Logistics Center, ATTN: MMEDT, McClellan AFB, California 95652.

2. Army - DA Form 2028 direct to: Commanding General, U.S. Army Troop Support and Aviation Materiel Readiness Command, Attention: DRSTS - MTP, St. Louis, Missouri 63120

3. Marine Corps - by letter direct to: Commandant, U.S. Marine Corps, ATTN: Code LME, Washington, D.C. 20380.

4. Navy - by letter direct to: Commanding Officer, U.S. Navy Ships Parts Control Center, ATTN: Code 783, Mechanicsburg, Pennsylvania 17055.

## Section II. DESCRIPTION AND DATA

### 1-3. DESCRIPTION.

A general description of the generator sets and information pertaining to the identification plates are contained in the Operator and Organizational Maintenance Manual. A more detailed description of specific components and assemblies is contained in the applicable section(s) of this manual. Detailed descriptions of the components of the generator set are provided in the applicable maintenance paragraphs of this manual.

### 1-4. TABULATED DATA.

This paragraph contains all maintenance data pertinent to intermediate (field) (direct and general support) and depot maintenance personnel.

| | |
|---|---|
| a. GENERATOR SET MANUFACTURER | Consolidated Diesel Electric Company<br>Old Greenwich, Connecticut |

| Model | Mode | Class |
|---|---|---|
| MEP009A | 50/60 Hertz | Utility |
| MEP108A | 50/60 Hertz | Precise |

Operating temperature range:

| | |
|---|---|
| without external heat | + 125 °F to -25° F |
| with external heat | + 125° F to -65° F |

| | |
|---|---|
| Voltage Output | 120/208 volts and 240/416 volts, 3 phase 4 wire, WYE connected at reconnection terminals. |
| Power Factor | 0.8 |

Capacities:

| | |
|---|---|
| Fuel System | 200 gallons |
| Cooling System | 24.25 gallons |
| Hydraulic System (precise generator sets only) | 6.5 quarts |

Dimensions and Weights:

| | |
|---|---|
| Overall Length | 114 inches |
| Overall Width | 50 inches |
| Overall Height | 75 inches |
| Net Weight Empty | 10,500 pounds |
| Net Weight Filled | 12,594 pounds |
| Shipping Weight | 11,300 pounds |

b. SAFETY DEVICES.

1. Overspeed Switch.

| | |
|---|---|
| DOD Drawing Number | 70-4058 |
| Manufacturer | Synchro - Start Products, Inc.<br>Skokie, Illinois 60076 |
| Type | Centrifugal, 3-element |
| Model Number | GO-3MA |

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| Model | Mode | Class |
|---|---|---|
| MEP009A | 50/60 Hertz | Utility |
| MEP108A | 50/60 Hertz | Precise |

Operating temperature range:

| | |
|---|---|
| without external heat | +125°F to -25°F (52°C to -32°C) |
| with external heat | +125°F to -50°F (52°C to -46°C) |

NOTE

At temperatures below -50°F(-46°C) the heater will require over 1 hour operation to start set.

| | |
|---|---|
| Voltage Output | 120/208 volts and 240/416 volts, 3 phase 4 wire, WYE connected at reconnection terminals. |
| Power Factor | 0.8 lagging |
| Capacities: | |
| Fuel System | 240 gallons (908 liters) |
| Cooling System | 24.25 gallons (92 liters) |
| Hydraulic System (precise generator sets only) | 6.5 quarts (6.2 liters) |
| Dimensions and weights: | |
| Overall Length | 114 inches (2.895 meters) |
| Overall Width | 50 inches (1.270 meters) |
| Overall Height | 75 inches (1.905 meters) |
| Net Weight Empty | 10,200 pounds (MEP009) (4620.600 kilograms)<br>10,350 pounds (MEP108) (4688.550 kilograms) |
| Net Weight Filled | 12,294 pounds (MEP009) (5569.182 kilograms)<br>12,444 pounds (MEP108) (5637.132 kilograms) |
| Shipping Weight | 11,000 pounds (MEP009) (4983.00 kilograms)<br>11,150 pounds (MEP108) (5050.950 kilograms) |

b. SAFETY DEVICES.

1. Overspeed Switch.

| | |
|---|---|
| DOD Drawing Number | 70-4058 |
| Manufacturer | Synchro - Start Products, Inc.<br>Skokie, Illinois 60076 |
| Type | Centrifugal, 3-element |
| Model Number | GO-3MA |

| | | |
|---|---|---|
| | Operating Temperature Range | + 150°F to -65°F (65.6°C to -53.9C) |
| | Functions | Disconnects starter, flashes generator field, and energizes precise governor on precise generator sets. |
| | Operating speed | Switch rotates at half of engine speed. |
| | Element 1 | Starter disconnect and field flash. SPDT contact arrangement. Contacts transfer at 290-310 RPM rising switch speed. Automatic reset 100 RPM maximum below trip speed. Contact rating 3 ampere inductive at 28 VDC. |
| | Element 2 | Energizes precise governor on precise generator sets not utilized on utility generator sets. SPST contacts close at 590-610 RPM rising switch speed. Automatic reset 100 RPM maximum below trip speed. Contact rating 10 amperes inductive at 28 VDC. |
| | Element 3 | Overspeed. Two separate SPST contact sets; one open, one closed. Transfers at 1200-1225 RPM rising switch speed. Manual reset by button on rear of switch. Contact rating 10 amperes inductive at 28 VDC. |
| | Weight | 1.50 pounds (approx.) (.680 kg) |
| | Overall dimensions | 2.60 dia. x 8.00 inches (approx.)<br>(6.604 x 2.032 cm) |
| 2. | Over Voltage Relay | |
| | DOD Drawing Number | 70-1138 |
| | Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| | Part Number | 11486 |
| | Nominal Voltage | 120 volts, 50 to 450 hertz |
| | Voltage Trip Point | |
| | 50 to 100 hertz operation | Trip at 156 volts $\pm^{0}_{2}$ volts |
| | Weight | 1 pound (approx.) (.453 kg) |
| | Overall dimensions | 3.09 x 3.44 x 2.66 inches (approx.)<br>(7.848 x 8.737 x 6.756 cm) |

| | |
|---|---|
| Time Delay | 0.18 to 0.8 second |
| Contact Rating | 10 amperes, 28.5 VDC resistive |
| Temperature Limits | -85°F to + 185°F (-65°C to 85°C) |
| Temperature Effect On Pull-In Voltage | Changes ± 1 volt at -85°F (-65°C)<br>Changes ± 1 volt at + 185°F (85°C) |
| Service Life | 5000 hours minimum |

3. Under Voltage Relay

| | |
|---|---|
| DOD Drawing Number | 70-1120 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 11636 |
| Nominal Input | 120 volts, 50 to 400 Hz, 100 milliamperes maximum |
| Dropout Voltage | 99 volts |
| Dropout Voltage Tolerance | ± 1 volt at 60 hertz and 75° F (24°C), ± 4 volts at any combination of frequency and temperature within specified limits. |
| Frequency Range | 50 to 400 hertz. Frequency trip effect ± 1.5 volt |
| Temperature Limits | -65°F to + 170°F (-54°C to 77°C). Temperature trip effect ±1.5 volt |
| Time Delay | 6 ± 2 seconds above 72 volts, instantaneous below 48 volts |
| Pull In Voltage | 112 volts |
| Contact Arrangement | DPDT. Terminals 3, 4 and 5 isolated from terminals 6, 7 and 8. Normally closed contacts are terminals 3 to 4 and terminals 6 to 7. |
| Contact Rating | 10 ampere resistive or 5 ampere inductive, 28 VDC. |
| Service Life | 5,000 hours minimum |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 4.28 x 3.375 x 3.53 inches (approx.)<br>(10.871 x 8.572 x 8.966 cm) |

### 4. Under Frequency Relay

| | |
|---|---|
| DOD Drawing Number | 70-1119 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 11638 |
| Nominal Input | 120 volt, 50 or 60 hertz,<br>200 milliamperes, maximum |
| Trip Frequency | 46 hertz for 50 hertz operation or 55 hertz for 60 hertz operation at 120 volts and 75°F (24°C) |
| Trip Frequency Selections | Switching between terminals 7 and 8. Switch closed for 50 hertz operation and open for 60 hertz operation. |
| Voltage Input Limits | ± 10 percent of nominal |
| Voltage Trip Effect | ± 0.2 hertz |
| Temperature Range | -65°F to + 170°F (-54 to 77°C) |
| Temperature Trip Effect | ± 0.2 hertz |
| Service Life | 5000 hours minimum |
| Contact Arrangement | Contacts 3 and 4 normally closed.<br>Contacts 5 and 6 normally open. |
| Contact Rating | 10 ampere resistive or 5 ampere inductive, 28 VDC |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 3.09 x 3.44 x 2.66 inches (approx.)<br>(7.848 x 8.737 x 6.756 cm) |

5. Short Circuit Relay

| | |
|---|---|
| DOD Drawing Number | 70-1137 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 22380 |
| Function | Trips if generator set output current exceeds 425 ± 25 percent of generator set rated current. |
| Trip Voltage | 24 volts at 60 hertz and 75°F (24°C) on any phase to neutral. |
| Trip Voltage Tolerance | ± 0.3 volt at 60 hertz and 75°F (24°C), ± 1.5 volt at any combination of frequency and temperature deviation within specified limits. |
| Frequency Range | 50 to 400 hertz. Frequency trip effect ± 0.6 volt. |
| Temperature Limits | -65°F to + 170°F (-54°C to 76.5°C). Temperature trip effect ± 0.6 volt. |
| Operating Time | Instantaneous |
| Contact Arrangement | Contacts 5 and 6 normally closed.<br>Contacts 7 and 8 normally open. |
| Contact Rating | 10 amperes resistive, 28 VDC |
| Service Life | 5000 hour minimum |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 3.09 x 3.44 x 2.66 inches (approx.) (7.848 x 8.737 x 6.756 cm) |

6. Reverse Power Relay

| | |
|---|---|
| DOD Drawing Number | 70-1136 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 21691-1 |
| Function | Trips when reverse power into generator set exceeds 20 percent of rated output. |
| DC Input Voltage | 0-10 VDC with AC signal superimposed on DC input, 20 volts maximum. |
| External Power | 24 VDC across terminals 3 and 4, terminal 3 is positive. |
| Trip Voltage | 2 VDC across terminals 1 and 2, terminal 1 is positive. (Corresponds to approximately 20 percent reverse power.) |
| Trip Voltage Tolerance | ± 0.1 VDC under standard conditions. ± 1 VDC with any combination of superimposed AC frequency and temperature within specified limits. |
| Frequency Range | 50 to 400 hertz. Frequency trip effect ± 0.4 VDC. |
| Temperature Limits | -65°F to +170°F (-53°C to 77°C). Temperature trip effect ± 0.5 volt. |
| Contact Arrangement | Contacts 5 and 6 normally open. Contacts 7 and 8 normally closed. |
| Contact Rating | 10 amperes resistive, 28 VDC |
| Service Life | 5,000 hour minimum. |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 3.09 x 3.44 x 2.66 inches (approx.)<br>(7.848 x 8.737 x 6.756 cm) |

7. Overload Relay

| | |
|---|---|
| DOD Drawing Number | 70-1135 |
| Manufacturer | Consolidated Diesel Electric Co.<br>Old Greenwich, Conn. |
| Part Number | 00000-4857 |

| | |
|---|---|
| Function | Trips if current in any place exceeds 110 percent of rated current on an inverse time principle. |
| AC Input (Signal) | 3 wire, 3 phase 50/60 Hz. 0.75 ampere per phase (at 100 percent rated load) |
| DC Input | 28 VDC 0.1 ampere maximum. |
| Time Delay | Operates in a minimum of 8 minutes ± 2 minutes after the current in any phase remains at 130 percent of rated current. |
| Temperature Limits | -65°F to +140°F (-54°C to 60°C) |
| Contact Arrangement | Two contacts, 1 normally open, 1 normally closed |
| Contact Rating | 10 ampere resistive or 5 ampere inductive, 28 VDC |
| Service Life | 5,000 hour minimum |
| Weight | 1 pound (approx.) (.453 Kg) |
| Overall dimensions | 3.87 x 2.68 x 3.62 inches (approx.)<br>(9.829 x 6.807 x 9.194 cm) |

8. Permissive Paralleling Relay

| | |
|---|---|
| DOD Drawing Number | 70-1118 |
| Manufacturer | Electromagnetic Industries Inc.<br>Clearwater, Florida |
| Part Number | 23390 |
| External Power Required | 24 VDC, 200 milliamperes maximum. |
| Input Signal AC Burden | 0-20 VAC, 60 to 400 hertz. At 300 VAC, 40 milliamperes maximum. |
| Contact Operation | 5 and 6 normally closed with AC signal above 10 volts. 7 and 8 normally open with AC signal above 8 ± 1 volt. |
| Contact Rating | 28 VDC, 10 amperes resistive, 5 amperes inductive. |
| Life Expectancy | 5,000 hours minimum |
| Weight | 1 pound (approx.) (0.453 kg) |
| Overall dimensions | 2.56 x 3.38 x 3.00 inches (approx.)<br>(6.502 x 8.585 x 7.620 cm) |

c. RADIATOR

| | |
|---|---|
| DOD Drawing Number | 70-4089 |
| Manufacturer | G & O Manufacturing Company<br>New Haven, Conn. |
| Part Number | X-1736 |
| Coolant Capacity | 39 quarts (36.909 liters) |

Heat Rejection:

| Water GPM flow | Engine RPM speed | Heat BTU/min. rejection |
|---|---|---|
| 160 (605.6 LPM) | 1500 (157.05 r/sec) | 36 (2.52 gram - cal/sec) |
| 190 (719.15 LPM) | 1800 (188.46 r/sec) | 35 (2.45 gram - cal/sec) |

| | |
|---|---|
| Air Test Pressure | 15 PSI (1.054 kg/cm$^2$) |
| Operating Pressure | 7 PSI (0.4921 kg/cm$^2$) |
| Weight | 260 pounds (approx.) (117.936 kg) |
| Overall dimensions | 40 x 48.22 x 10.00 inches (approx.)<br>(101.60 x 122.478 x 25.40 cm) |

d. LOUVER AND CONTROL ASSEMBLY

| | |
|---|---|
| DOD Drawing Number | 70-4093 |
| Manufacturer | The Cadillac Company<br>Coldwater, Michigan |
| Part Number | 1G334 |
| Type | 38 vanes, center control, with left hand manual control handle, thermostat operated |
| Control Element Setting | Nominal 170°F (77°C) (158°F (70°C) crack open, 173°F (78°C) full open) |
| Weight | 22 pounds (9.979 kg) (approx.) |
| Overall dimensions | 39.38 x 38.25 x 2.5 inches (approx.)<br>(100.025 x 97.155 x 6.35 cm) |

## e. GENERATOR CONTROL ASSEMBLY

### 1. DC Circuit Breaker

| | |
|---|---|
| DOD Drawing Number | MS25244-71-2 |
| Rating | 24 VDC 7.5 amperes |
| Circuit Breaker Reset | Manual |
| Contact Arrangement | SPST |
| Weight | 0.25 pound (approx.) (1.134 g) |
| Overall dimensions | 2.00 x 1.80 x 0.75 inches (approx.)<br>(5.08 x 4.572 x 1.905 cm) |

### 2. Convenience Receptacle Box Assembly

| | |
|---|---|
| DOD Drawing Number | 70-4101 |
| Number of Receptacles | 1 duplex |
| Voltage | 120 VAC |
| Current | 15 amperes |
| Circuit Breaker Reset | Manual |
| Weight | 5 pounds (approx.) (2.268 kg) |
| Overall dimensions | 9.62 x 3.0 x 5.50 inches (approx.)<br>(24.435 x 7.62 x 13.97 cm) |

### 3. Exciter Regulator (Voltage)

| | |
|---|---|
| DOD Drawing Number | 70-4145 |
| Manufacturer | Consolidated Diesel Electric Co.<br>Old Greenwich, Connecticut |
| Type | Solid state, with capability to automatically flash field of generator. |
| Voltage Regulation: | |
| Precise Sets | 1 percent of rated voltage |
| Utility Sets | 3 percent of rated voltage |

| | |
|---|---|
| Voltage Stability:<br>Short Term (30 seconds) | |
| Precise Sets | within bandwidth equal to 1 percent of rated voltage |
| Utility Sets | within bandwidth equal to 2 percent of rated voltage |
| Long Term (4 hours) | |
| Precise Sets | within bandwidth equal to 2 percent of rated voltage |
| Utility Sets | within bandwidth equal to 4 percent of rated voltage |
| Voltage Drift (8 hours) | 1 percent |
| Transient performance (application or rejection of load). | |
| Resumption of steady state condition: | |
| Precise Sets | within 0.5 seconds |
| Utility Sets | within 3 seconds |
| Overshoot and Undershoot: | |
| Precise Sets | 15 percent of rated voltage |
| Utility Sets | 20 percent of rated voltage |
| Weight | 40 pounds (18.144 kg) (approx.) |
| Overall dimensions | 20.0 x 6.50 x 9.88 inches (approx.)<br>(50.8 x 16.51 x 25.096 cm) |

4. Circuit Breaker Assembly (CB2)

| | |
|---|---|
| DOD Drawing Number | 71-4929 |
| Manufacturer | General Electric Co., Plainville, Connecticut |
| Part Number | 343L695 RPG1 |
| Main Contacts | 3 pole normally open |
| Current Rating at 50/60 Hz | 700 amperes continuous at 208 volts and 350 amperes at 416 volts |
| Interrupting Capability | 20,000 amperes at 208 volts |

| | |
|---|---|
| Temperature Range | -65°F to +135°F (-54°C to 57°C) |
| Trip Force | 48 oz. (1.360 kg) |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 8.25 x 8.00 x 15.50 inches (approx.)<br>(20.955 x 20.32 x 39.37 cm) |

5. Current Transformer Assembly

(a) Current transformer (CT1, CT2, and CT3)

| | |
|---|---|
| DOD Drawing Number | 70-4062 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 7LM |
| Primary Current | 928 amperes |
| Primary Voltage | 600 volts |
| Secondary Current | 1 ampere |
| Turns Ratio | 1 primary to 928 secondary |
| Frequency | 50/60 hertz |
| Burden | 12.5VA minimum at 1 ampere secondary current |
| Temperature Range | -65°F to +155°F (-54°C x 68°C) |
| Weight | 3 pounds (approx.) (1.360 kg) |
| Overall dimensions | 4.56 x 4.56 x 2.12 inches (approx).<br>(11.582 x 11.582 x 5.384 cm) |

(b) Current Transformer CT4

| | |
|---|---|
| DOD Drawing Number | 70-4067 |
| Manufacturer | Consolidated Diesel Electric Co.<br>Old Greenwich, Connecticut |
| Part Number | 00000-4921 |
| Total Turns | 260 |
| Rated Voltage | 60 VAC |
| Rated Current | 2.7 amperes |
| Resistance 0.8 | 0.83 ohms |

| | |
|---|---|
| Frequency | 60 hertz |
| Excitation Current | With 60 volts RMS applied, exciting current is 0.30 amperes maximum |
| Temperature Range | -65°F to +155°F (-54°C to 68°C) |
| Weight | 3 pounds (approx.) (1.360 kg) |
| Overall dimensions | 5.38 x 5.38 x 3.50 inches (approx.)<br>(13.665 x 13.665 x 8.89 cm) |

(c) Current transformer CT5 and CT6

| | |
|---|---|
| DOD Drawing Number | 70-4086 |
| Manufacturer | Consolidated Diesel Electric Company<br>Old Greenwich, Connecticut |
| Part Number | 00000-4922 |
| No Load Voltage | 60 volts |
| Current | 8.0 amperes |
| Resistance | 0.22 ohms |
| Frequency | 50/60 Hertz |
| Excitation Current | 0.90 amperes maximum |
| Total Turns | 87 |
| Temperature Range | -65°F to + 155°F (-54°C to 68°C) |
| Weight | 3 pounds (approx.) (1.360 kg) |
| Overall dimensions | 5.38 x 5.63 x 6.0 inches (approx.)<br>13.665 x 14.300 x 15.24 cm) |

(d) Current transformer CT7

| | |
|---|---|
| DOD Drawing Number | 70-4063 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 7 (800/1 Ratio) |
| Primary Current | 1200 amperes |
| Primary Voltage | 600 volts |
| Secondary Current | 1.5 amperes |

| | |
|---|---|
| Turns Ratio | 1 primary to 800 secondary |
| Frequency | 50/60 hertz |
| Burden | 50VA minimum |
| Temperature Range | -65°F to + 155°F (-54°C to 68°C) |
| Weight | 3 pounds (approx.) (1.360 kg) |
| Overall dimensions | 4.50 x 1.25 inches (approx.)<br>(11.43 x 3.175 cm) |

6. Precise Governor System (LEH GOVERNOR)

| | |
|---|---|
| Type | Closed loop feedback system |

(a) Governor control unit

| | |
|---|---|
| Type | Solid state |
| DOD Drawing Number | 69-784-2 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 22810 |
| Input Voltage | 24 VDC and single phase<br>120 VAC from generator output |
| Weight | 7 pounds (approx.) (3.175 kg) |
| Overall dimensions | 10.41 x 10 x 4.06 inches (approx.)<br>26.441 x 25.4 x 10.312 cm) |

(b) Governor actuator unit

| | |
|---|---|
| DOD Drawing Number | 69-790-3 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Part Number | 23600-3 |
| Type | Hydraulic, differential pressure operated |
| Piston Position Transducer | Variable reluctance type |

| | |
|---|---|
| Input Pressure | 300 to 320 PSI (21.092 to 22.498 kg/cm$^2$) |
| Hydraulic Fluid Type | MIL-H-5606 |
| Input Voltage | 120 volts |
| Frequency | 50/60 or 400 hertz |
| Weight | 3 pounds (approx) (1.360 kg) |
| Overall dimensions | 6.00 x 2.91 x 4.90 inches (approx.)<br>(15.24 x 7.391 x 12.446 cm) |
| (c) Hydraulic Pump | |
| DOD Drawing Number | 70-4038 |
| Manufacturer | Consolidated Diesel Electric Company<br>Old Greenwich, Connecticut |
| Part Number | GC 5100A82A |
| Type | Gear driven, positive displacement |
| Rating | 2 GPM (7.57 LPM) |
| Drive Type | Tang with drive coupling |
| Relief Valve Type | Adjustable plunger |
| Pressure | 320 ± 10 PSI (22.496 ± 0.703 kg/cm$^2$) |
| Drive Speeds | 1500 to 2116 RPM |
| Rotation | Clockwise (viewed from drive end) |
| Weight | 10 pounds (approx.) (4.536 kg) |
| Overall dimensions | 3.56 x 3.56 x 2.81 inches (approx.)<br>(9.042 x 9.042 x 7.137 cm) |
| (d) Hydraulic Tank Assembly | |
| DOD Drawing Number | 71-4388 |
| Type | Welded with filler cap level gauge. |
| Capacity | 6 quarts (5.677 liters) |
| Type Fluid | MIL-H-5606 |
| Weight | 12 pounds (approx.) (5.443 kg) |
| Overall dimensions | 14.00 x 8.12 x 4.12 inches (approx.)<br>(35.56 x 20.625 x 10.465 cm) |
| 7. Load Measuring Unit | |
| DOD Drawing Number | 69-785 |
| Manufacturer | Electromagnetic Industries, Inc.<br>Clearwater, Florida |
| Type | Electrical, three phase load sensing |
| Part Number | 69-500 |

| | |
|---|---|
| Frequency Regulation | Isochronous ± 1/4 of 1 percent. |
| Frequency Stability: | |
| Short Term (30 Seconds) | within bandwidth equal to 1/2 of 1 percent of rated frequency. |
| Long Term (4 Hours) | within bandwidth equal to 1 percent of rated frequency. |
| Frequency Drift (8 Hours) | 1/2 of 1 percent. |
| Transient performance (application or rejection of 50% load). | |
| Stable Operation | within 2 seconds. |
| Overshoot or Undershoot | 4 percent of rated frequency |
| Weight | 3 pounds (approx.) (1.360 kg) |
| Overall dimensions | 6.00 x 3.80 x 4.38 inches (approx.)<br>(15.24 x 9.652 x 11.125 cm) |

f. GENERATOR

| | |
|---|---|
| DOD Drawing Number | 70-4003 |
| Manufacturer | Lima Electric Motor Company |
| Type | 50/60 Hertz<br>Synchronous, brushless, with integral exciter. |
| Operating Speed: | |
| 50 Hertz | 1500 RPM |
| 60 Hertz | 1800 RPM |
| Kilowatt Rating (KW): (At 0.8 P.F.) | |
| 50 Hertz | 166.6 |
| 60 Hertz | 200 |

Kilovolt Ampere Rating (KVA):

| | |
|---|---|
| 50 Hertz | 208 |
| 60 Hertz | 250 |

Current rating for 3 phase balanced rated load with generator coils connected in WYE at reconnection terminals.

| | |
|---|---|
| 50 Hertz: | |
| 120/208 Volts | 576 |
| 240/416 Volts | 288 |
| 60 Hertz: | |
| 120/208 Volts | 692 |
| 240/416 Volts | 346 |
| Weight | 2,200 pounds (approx.) (997.92 kg) |
| Overall dimensions | 46 x 37 x 28 inches (approx.)<br>(116.84 x 93.98 x 71.12 cm) |

g. ENGINE

| | |
|---|---|
| DOD Drawing Number | 70-4014 |
| Manufacturer | Caterpillar Tractor Company<br>Peoria, Illinois |
| Type | Four stroke cycle, liquid cooled, turbo charged, after cooled, diesel. |
| Part Number | 5R1264 |
| Model | D343T/A |
| Number of Cylinders | Six |
| Piston Displacement | 893 cubic inches (14.636 liters) |
| Rotation | Counterclockwise from flywheel end. |
| Lubricating Oil Capacity | 42 quarts (39.748 liters) |
| Weight | 4,235 pounds (approx.) (1920.996 kg) |
| Overall dimensions | 58.75 x 47.29 x 36.00 inches (approx.)<br>(149.225 x 120.16 x 91.44 cm) |

## h. ENGINE ACCESSORIES

### 1. Battery Charging Alternator

| | |
|---|---|
| DOD Drawing Number | 69-780-2 |
| Manufacturer | Motorola, Inc.<br>Franklin Park, Ill. |
| Part Number | 70D44672802 |
| Type | Alternator with integral voltage regulator and transient voltage suppressor |
| Rating | 0-35 amperes at any speed from 1900 to 4000 RPM within temperature limits |
| Temperature limits | -65°F to + 175°F (-54° to 79°C) |
| Drive | V-belt, 0.500 nominal width |
| Maximum voltage under load removal or other condition | 32 volt average, 50 volt spikes or transients |
| Fuse rating | Style 4AG, 32 volts, 40 amperes |
| Field (rotor) current | 1.25 to 1.75 amperes at 24.0 volts<br>(113.398 to 170.097 g) |
| Brush Spring Tension | 4 to 6 ounces |
| Rotor Assembly Resistance | 11 to 14 ohms |
| Weight | 13.5 pounds (approx.) (6.123 kg) |
| Overall dimensions | 8.34 x 7.40 x 5.50 inches (approx.)<br>(21.184 x 18.796 x 13.97 mm) |

### 2. Starter Motor

| | |
|---|---|
| DOD Drawing Number | 70-4049 |
| Manufacturer | Delco Remy<br>Anderson, Indiana 46011 |
| Part Number | 1109636 |
| Type | Heavy Duty |

| | |
|---|---|
| Operating voltage | 24 VDC |
| Brushes | 8 brushes in 4 brush holders |
| Rotation | Clockwise, drive end |
| Engagement | Indexing type |
| Actuation | Shifting solenoid, mounted on motor |
| Solenoid Coil Current (Pull-in current @ 80°F) | 55 to 63 amperes |
| Solenoid Coil Current (Hold-in current @ 80°F) | 7 to 9 amperes |
| Weight | 7.5 pounds (approx.) (3.402 kg) |
| Overall dimensions | 20.80 x 9.00 inches (approx.)<br>(52.832 x 22.86 cm) |

3. Day Tank Fuel Level Switch

| | |
|---|---|
| DOD Drawing Number | 70-1594 |
| Manufacturer | Deval Gems Sensor Div.<br>Farmington, Ct. 06032 |
| Part Number | LS40820 |
| Contact Rating | 6 to 32 VDC, 50 watts maximum, 3.0 amperes maximum |
| Operating Pressure | 0 to 150 PSI (0 to 10.546 kg/sq cm) |
| Temperature Limits | -65°F to + 200°F (-54°C to 93.3°C) |
| Fuel Type | JP5, JP4 or VV-F-800 |
| Switch Arrangement | 2 switches upper and lower NO |
| Switch Operation | At full level, switches are NO. At low level, switches are NC. At middle level, upper switch NC and lower switch open. |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 2.00 x 10.00 inches (approx.)<br>(5.08 x 25.4cm) |

4. Tachometer Drive

| | |
|---|---|
| Manufacturer | Caterpillar<br>Peoria, Illinois |
| Part Number | 5R1944 |
| Operating Speed | One half engine RPM |
| Drive Connection | S.A.E. Heavy duty 3/16 (4.763 mm) pin and tang |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 3.00 x 2.00 x 2.50 inches (approx.) (7.62 x 5.08 x 6.35 cm) |

5. Fuel Transfer Pump

| | |
|---|---|
| Manufacturer | Caterpillar, Peoria, Illinois |
| Part Number | 4N4873 |
| RPM | 400 RPM |
| Flow Rate | 28 GPH (105.98 LPH) |
| Discharge | 20 PSI (1.406 kg/sq cm) |
| Weight | 1.5 pounds (approx.) (.680 kg) |
| Overall dimensions | 2.75 x 3.40 x 2.75 inches (approx.) (6.985 x 8.636 x 9.85 cm) |

6. Turbocharger

| | |
|---|---|
| Manufacturer | Air Research Manufacturing Corporation<br>Los Angeles, California |
| Part Number | 402910-29 |
| RPM at Rated Load | 49,000 RPM @ 1800 RPM |
| Method of Lubrication | Engine oil system 2 to 3 GPM (7.57 to 11.35 LPM) |
| Intake Manifold Pressures at Rated Load | 24 to 26 inches (60.96 to66.04 cm) mercury @ 1800 RPM |
| Weight | 70 pounds (approx.) (31.752 kg) |
| Overall dimensions | 10.00 x 13.00 x 15.00 inches (approx.) (25.4 x 33.02 x 38.1 cm) |

7. Oil Cooler

| | |
|---|---|
| Manufacturer | Caterpillar<br>Peoria, Illinois |
| Part Number | 3N3444 |
| Coolant Flow | Engine jacket water through tubes 110 GPM (416.35 LPM) |
| Oil Flow | Baffled flow around outside diameter of tubes 45 GPM (170.325 LPM) |
| Working Pressure | 75 PSI (5.273 kg/sq cm) |
| Pressure Test at | 115 PSI (8.084 kg/sq cm) |
| Weight | 150 pounds (approx.) (68.04 kg) |
| Overall dimensions | 19.28 x 5.12 DIA. (approx.) (489.7 x 130 mm) |

8. Water Pump

| | |
|---|---|
| Manufacturer | Caterpillar Peoria, Illinois |
| Part Number | 5R1605 |
| Type | Centrifugal |
| Type of Drive | Gear driven |
| Water Flow Rate | 190 GPM (719.15 LPM) at 1800 RPM |
| Weight | 25 pounds (approx.) (11.34 kg) |
| Overall dimensions | 9.00 x 10.00 x 13.00 inches (approx.) (22.86 x 25.4 x 33.02 cm) |

9. Utility Governor

| | |
|---|---|
| Manufacturer | Woodward Governor Company<br>Rockford, Illinois |
| Part Number | 8510-232 |
| Type | Hydraulic speed droop |
| Frequency Regulation | Adjustable from 1-1/2 to 3 percent of rated frequency |

| | |
|---|---|
| Frequency Stability: | |
| Short Term (30 Seconds) | within bandwidth equal to 2 percent of rated frequency |
| Long Term (4 Hours) | within bandwidth equal to 3 percent of rated frequency |
| Frequency Drift (8 Hours) | 1 percent |
| Transient Performance: (application or rejection of load) | |
| Stable Operation | within 2 seconds |
| Overshoot | 4 percent of rated frequency |
| Undershoot | 3 percent of rated frequency |
| Weight | 7.00 pounds (approx.) (3.175 kg) |
| Overall dimensions | 5.30 x 7.50 x 6.25 inches (approx.) (13.462 x 19.05 x 15.875 cm) |
| 10. Fuel Injection Pump | |
| Manufacturer | Caterpillar<br>Peoria, Illinois |
| Part Number | 5R835 |
| Firing Order | 1-5-3-6-2-4 |
| Injection Timing | 11 degrees, (.1919 radians) before top dead center |
| Number of Individual Pumps | 6 |
| Type of Drive | Gear driven |
| Speed | One half engine RPM |
| Weight | 20 pounds (approx.) (9.072 kg) |
| Overall dimensions | 12.00 x 6.50 x 6.00 inches (approx.) (30.48 x 16.51 x 15.24 mm) |

## i. FUEL BURNING WINTERIZATION KIT (Optional)

| | |
|---|---|
| DOD Drawing Number | 71-4420 |
| Manufacturer | Consolidated Diesel Electric Company<br>Old Greenwich, Connecticut |

### 1. Engine Heater

| | |
|---|---|
| DOD Drawing Number | 69-775 |
| Manufacturer | Test Institute Corporation<br>Benmar Heater Division<br>Cleveland, Ohio |
| Part Number | CP3050-24 |
| Fuel | JP 4, Arctic diesel fuel, JP 5 |
| Fuel Rate | 21 to 23 cc per minute |
| Fuel Pressure | 3 to 15 PSI (.211 to 1.054 kg/sq cm) |
| Relief valve setting | 30 to 35 PSI (2.109 to 2.460 kg/sq cm) |
| Voltage | 24 VDC |
| Radio Interference Suppression | 0.15 to 1000 mega-cycles |
| Coolant Circulation | 80-100 GPH (302.8 - 378.5 LPH) at 10 PSI (703 kg/cm$^2$) |
| Output | |
| Transfer to Coolant | 30,000 BTU per hour maximum (2100 gram - cal/sec) |
| Usable Exhaust Heat | 10,000 BTU per hour maximum (700 gram - cal/sec) |

| | |
|---|---|
| Operating Power Requirements | |
| Above + 30°F | |
| Start | 14.5 amperes |
| Run | 5.0 amperes |
| Below + 30°F | |
| Start | 17.0 amperes |
| Run | 7.5 amperes |
| Weight | 20 pounds (approx.) (9.072 kg) |
| Overall dimensions | 19.82 x 10.12 x 6.32 inches (approx.) (50.343 x 25.704 x 16.053 cm) |
| 2. Coolant Thermostat Switch | |
| DOD Drawing Number | 70-4045 |
| Manufacturer | NASON Company<br>Clarkston, Michigan. |
| Part Number | TC-1258-50M-4AN |
| Contacts Rating | 28 VDC,<br>10 amperes |
| Contacts Arrangement | 2 contacts normally closed |
| Contacts Operation | contacts open between +120 and 130°F(48.88 and 54.44°C), contacts close between +45 and 55°F (7.22 and 12.77°C). |
| Temperature Limits | -65°F to + 230°F. (-53.89°C to 110°C) |
| Life Expectancy | 1 year or 5,000 operating hours. |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 2.44 x 4.75 inches (approx.) (6.198 x 12.065 cm) |
| 3. Control Box | |
| DOD Drawing Number | 69-650 |
| Circuit Breaker Type | Manual reset. |
| Circuit Breaker Current | 15 amperes |
| Switch Arrangement | 2 PST normally open |
| Control Box Function | Protects heater circuitry against overload, in OFF position heater will continue to operate for 4 1/2 minutes. |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 5.75 x 4.50 x 3.00 inches (approx.) (14.605 x 11.43 x 7.62 cm) |
| j. ELECTRIC WINTERIZATION KIT | (Optional) |
| DOD Drawing Number | 71-4440 |

| | |
|---|---|
| Manufacturer | Consolidated Diesel Electric Company |

1. Electric coolant heater 4000 Watts

| | |
|---|---|
| DOD Drawing Number | 70-4072 |
| Manufacturer | Kim Hotstart Manufacturing Co.<br>Spokane, Washington. |
| Part Number | E220 |
| Rating | 4000 watts at 230 volts (nominal,<br>50/60 and 400 hertz |
| Operating Voltage | 208 to 240 volts. (113.55 to 151.4 liters) |
| Flow Rate | 30 to 40 gallons (113.55 to 151.4 liters) per hour maximum |
| Type | Gravity flow, and must have head pressure. |
| Operating Life | 1500 hours minimum at -65°F (-53.89°C) ambient. |
| Coolant | Arctic anti-freeze per MIL-A-11755. |
| Duty Cycle | Continuous |
| Weight | 1.5 pounds (approx.) (.680 kg) |
| Overall dimensions | 4.00 x 18.25 x 5.00 inches (approx.)<br>(10.16 x 46.35 x 12.7 cm) |

2. Pump motor assembly

| | |
|---|---|
| DOD Drawing Number | 70-4048 |
| Manufacturer | Welton Tool Company<br>Cleveland, Ohio |
| Part Number | P400-E (Rev. B) |
| Rating | 80 GPH (302.8 liters) Minimum at 2 PSI (.1406 kg/sq cm) |
| Voltage | 24 VDC |
| Duty classification | Continuous |
| Motor | |
| Voltage | 20-32V DC |
| Amperes | 3.3 maximum at 80°F (26.67°C) |
| RPM | 7500 |
| Coolant | Mil-A-11755 |
| Relief Valve | Opens at 30 to 35 PSI (2.109 to 2.460 kg/sq cm) |
| Weight | 2.5 pounds (approx.) (1.132 kg) |
| Overall dimensions | 3.62 x 3.69 x 7.5 inches (approx.)<br>(9.194 x 9.372 x 19.05 cm) |

3. Control Box

| | |
|---|---|
| DOD Drawing Number | 70-4196 |
| Voltage | 205 to 240 VAC |
| Frequency | 50/60 or 400 Hz |
| Phase | Single |
| Current | 30 amperes |
| Operation | Manual |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 9.50 x 3.25 x 5.56 (24.13 x 8.255 x 14.122 cm) |

4. Electric heater coolant thermostat

| | |
|---|---|
| DOD Drawing Number | 70-4074 |
| Manufacturer | Kim Hotstart Manufacturing Co.<br>Spokane, Washington. |
| Part Number | KS 1012 |
| Switch Type | SPST |
| Switch Rating | 25 amperes at 240 volts, 50/60 and 400 hz. |
| Cycling Operation | At -65°F (-54°C) ambient contact to open at 120°F (49°C) (increasing temperature) and close at 100°F (38°C) (decreasing temperature) |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 2.00 x 2.38 x 3.90 inches (approx.)<br>(5.08 x 6.045 x 9.906 cm) |

k. DUMMY LOAD KIT

| | |
|---|---|
| DOD Drawing Number | 71-4660 |
| Manufacturer | Consolidated Diesel Electric Company<br>Old Greenwich, Connecticut |
| Type | Resistive, 3 phase, 4 wire |
| Voltage | 120/208 and 240/416 |
| Kilowatt Rating (KW) | 96 KW |
| Increments of change | 24 KW |
| Weight | 425 pounds (approx.) (192.78 kg) |
| Overall dimensions | 96.00 x 35.00 x 22.75 inches (approx.)<br>(243.84 x 88.9 x 57.785 cm) |

1. Power Transformer

| | |
|---|---|
| DOD Drawing Number | 71-4837 |
| Manufacturer | Consolidated Diesel Electric Company<br>Old Greenwich, Connecticut |
| Part Number | 00000-4842 |
| No Load Voltage | 230 volts. |
| Frequency | 50, 60, and 400 hertz |
| Rating | |
| Primary terminals 1 and 2, 3 and 4 | 230 volts and 6.5 ohms |
| Secondary terminals 5 and 6 | 35 volts, 0.06 ohms, and 6.0 amperes |
| Total Turns | |
| primary terminals 1 and 2 | 460 |
| 3 and 4 | 460 |
| secondary terminals 5 and 6 | 70 |
| Temperature limits | -65°F to + 155°F. (-54°C to68°C) |
| Weight | 2 pounds (approx.) (.9072 kg) |
| Overall dimensions | 4.50 x 3.81 x 4.56 inches (approx.) (11.43 x 9.677 x 11.582 cm) |

2. Load Dump Relay Assembly

| | |
|---|---|
| DOD Drawing Number | 71-4716 |
| Manufacturer | Consolidated Diesel Electric Company<br>Old Greenwich, Connecticut |
| Part Number | 00000-4938 |
| External Power Required | 20 to 32 VDC. |
| Input Signal | 0 to 10 VDC. |
| Trip Voltage | 5.28 VDC ± 5 percent |
| Contact Rating | 26 VDC, 10 amperes resistive, 5 amperes inductive |
| Weight | 0.50 pounds (approx.) (.226 kg) |
| Overall dimensions | 3.25 x 2.62 x 3.00 inches (approx.) (8.255 x 6.654 x 7.62 cm) |

3. Electrical Heating Element

| | |
|---|---|
| DOD Drawing Number | 70-4047 |
| Manufacturer | General Electric Company<br>Shelbyville, Indiana |
| Part Number | 2A838B101 |
| Voltage Rating | 120 volts |
| Power Rating | 1000 watts |
| Watts per Square Inch | 7.8 watts |
| Life Expectancy | 10,000 hours |
| Skin Temperature | 1,000°F (537.7°C) |
| Weight | 2 pounds (approx.) (.907 kg) |
| Overall dimensions | 38.50 x 1.50 x 1.00 inches (approx.)<br>(97.79 x 3.81 x 2.54 cm) |

4. Load Contactor

| | |
|---|---|
| DOD Drawing Number | 71-4827 |
| Manufacturer | Rowan Controller Co.<br>Westminister, Maryland |
| Part Number | 2160-B730JA |
| Contact Arrangement | 3 pole normally open |
| Contact Rating at 50/60 and 400 Hz. | 42 amperes resistive at 208 volts and 21 amperes at 416 volts |
| Coil Data | |
| Voltage Rating | 24 to 32 VDC |
| Input Current | 4.5 amperes |
| Holding Current | 0.9 amperes |
| Temperature Range | -65°F to + 125°F (-54°C to 52°C) |
| Mounting Position | Vertical only. |
| Weight | 1 pound (approx.) (.453 kg) |
| Overall dimensions | 3.15 x 2.50 x 3.75 inches (approx.)<br>8.001 x 6.35 x 9.525 cm) |

l. REPAIR AND REPLACEMENT STANDARDS. Table 1-1 list manufacturer's dimensions, tolerances, desired clearances, and maximum allowable wear and clearances.

m. TORQUE DATA. Components not listed in table 1-2 should be tightened to standard torque values. Table 1-2 lists components that require special torques.

Table 1-1. Repair and Replacement Standards

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Starting Motor Assembly: | | | | | |
| Brush Length | 0.7500 | 0.7600 | | | 0.3750 |
| Thrust washer thickness (Commutator end of armature shaft) | 0.0570 | 0.0670 | | | 0.508 |
| Thrust washer thickness (Drive end of armature shaft) | 0.1800 | 0.1960 | | | 0.1750 |
| Maximum end play of armature | | | | | 0.0700 |
| Lever shaft intermediate diameter | 0.4980 | 0.5000 | | | 0.4970 |
| Lever bore for shaft | 0.5100 | 0.5120 | | | 0.5090 |
| Fit of shaft in shift lever | | | 0.0100L | 0.0140L | * |
| Commutator end plate sleeve bearing inside diameter | 0.6860 | 0.6880 | | | 0.6850 |
| Armature shaft diameter at commutator end | 0.6835 | 0.6845 | | | 0.6825 |
| Fit of shaft in bearing | | | 0.0015L | 0.0045L | 0.0090L |

* - L - T - See footnotes at end of table.

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Starting Motor Assembly: (continued) | | | | | |
| Commutator end plate bore | 0.8740 | 0.8750 | | | 0.8730 |
| Commutator end plate sleeve bearing outside diameter | 0.8800 | 0.8820 | | | * |
| Fit of bearing in end plate | | | 0.0050 | 0.0080T | * |
| Lever housing sleeve bearing inside diameter | 0.8335 | 0.8355 | | | 0.8325 |
| Armature shaft diameter | 0.8225 | 0.8240 | | | 0.8215 |
| Fit of shaft in bearing | | | 0.0095L | 0.0130L | 0.0260L |
| Lever housing bore | 0.9570 | 0.9580 | | | 0.9560 |
| Lever housing sleeve bearing outside diameter | 0.9630 | 0.9650 | | | * |
| Fit of bearing in housing | | | 0.0050 | 0.0080T | * |
| Drive housing sleeve bearing inside diameter | 0.6240 | 0.6260 | | | 0.6230 |
| Armature shaft diameter (Drive end) | 0.6220 | 0.6230 | | | 0.6210 |
| Fit of shaft in bearing | | | 0.0010L | 0.0040L | 0.0080L |

* - L - T - See footnotes at end of table.

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Starting Motor Assembly: (continued) | | | | | |
| Drive housing bore | 0.7490 | 0.7500 | | | * |
| Drive housing sleeve bearing outside diameter | 0.7550 | 0.7570 | | | * |
| Fit of bearing in housing | | | 0.0050T | 0.0080T | * |
| Armature shaft diameter (Drive end) | 0.6220 | 0.6230 | | | 0.6210 |
| Fit of shaft in bearing | | | 0.0015L | 0.0040L | 0.0080L |
| Commutator diameter | 2.3080 | 2.3180 | | | * |
| Commutator minimum turned diameter | | | | | 2.1930 |
| Commutator diameter T.I.R. eccentricity with shaft diameters at bearings | 0.0020 | | | | * |
| Fuel Pump Group: | | | | | |
| Bearing bore | 0.4950 | 0.4956 | | | * |
| Body bore depth | 0.3747 | 0.3753 | | | * |
| Gear to cover total clearance | | | 0.001 | 0.003 | 0.0035 |

* - L - T - See footnotes at end of table.

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Fuel Pump Group: (continued) | | | | | |
| Shaft diameter | 0.4936 | 0.4938 | | | 0.4926 |
| Shaft bearing bore | 0.4950 | 0.4956 | | | 0.003 |
| Turbocharger Group: | | | | | |
| Shaft end clearance | | | 0.0040 | 0.0090 | 0.011 |
| Thrust collar thickness | 0.2990 | 0.3000 | | | 0.2980 |
| Shaft bearing journal diameter | 0.6247 | 0.6250 | | | 0.6237<br>* |
| Bearing bore | 0.6268 | 0.6272 | | | 0.004 |
| Shaft run out (maximum) | | | | | 0.002 |
| Oil seal ring gap | 0.003 | 0.011 | | | 0.015 |
| Oil seal ring width | 0.0665 | 0.0670 | | | * |
| Oil seal ring groove width | 0.0695 | 0.0715 | | | * |
| Bore in housing for bearing | 0.9830 | 0.9835 | | | * |
| Bearing outside diameter | 0.9780 | 0.9785 | | | 0.007 |
| Thrust bearing thickness | 0.090 | 0.092 | | | 0.089 |
| Thrust bearing (to face of plate depth) | 0.396 | 0.398 | | | 0.399 |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Water Pump Group: (continued) | | | | | |
| Cover to impeller clearance | | | 0.003 | 0.020 | * |
| Utility Governor Group: | | | | | |
| Terminal lever I. D. | 0.352 | 0.356 | | | 0.0005 |
| Power piston O. D. | 0.7486 | 0.7490 | | | 0.0005 |
| Pilot valve: | | | | | |
| Larger lands (3) O. D. | 0.2490 | 0.2495 | | | 0.0005 |
| Small land (1) O. D. | 0.2485 | 0.2495 | | | 0.0005 |
| Pilot valve bushing: | | | | | |
| Bushing O. D. | 0.5635 | 0.5645 | | | 0.0005 |
| Spline end O. D. | 0.504 | 0.504 | | | 0.0005 |
| Large diameter I. D. | 0.281 | 0.281 | | | 0.0005 |
| Small diameter I. D. | 0.2475 | 0.2485 | | | 0.0005 |
| Gear lands (3) O. D. | 0.5675 | 0.5685 | | | 0.0005 |
| Bushing (2) I. D. | 0.376 | 0.377 | | | 0.0005 |
| Speed adjusting shaft O. D. | 0.373 | 0.3735 | | | 0.001 |
| Terminal shaft O. D. | 0.373 | 0.374 | | | 0.001 |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLFARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Utility Governor Group: (continued) | | | | | |
| Relief valve sleeve I. D. | 0.187 | 0.188 | | | 0.0005 |
| Relief valve sleeve O.D. | 0.4370 | 0.4373 | | | 0.0005 |
| Idler gear stud O. D. | 0.3130 | 0.3133 | | | 0.0005 |
| Idler gear O.D. | 1.120 | 1.216 | | | 0.0005 |
| Idler gear I. D. (measured over 0.148 diameter pins) | 0.3140 | 0.3150 | | | |
| Drive gear O.D. | 1.120 | 1.126 | | | 0.001 |
| Relief valve plunger O.D. | 0.182 | 0.184 | | | 0.0005 |
| Fuel Injection Group: | | | | | |
| Rack bearing bore | | | | | |
| Rear bearing | 0.5011 | 0.5037 | | | * |
| Front bearing | 0.5008 | 0.5038 | | | * |
| Fuel rack diameter | 0.4983 | 0.4987 | | | * |
| Fuel rack bearing clearance | | | | | 0.005 |
| Pump plunger length | 2.7209 | 2.7215 | | | 2.7159 |
| Camshaft bearing bore | 2.1245 | 2.1255 | | | |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Fuel Injection Group: (continued) | | | | | |
| Camshaft bearing journal diameter | 2.1215 | 2.1225 | | | 2.1205 |
| Camshaft bearing clearance | | | | | 0.010 |
| Accessory Drive Group: | | | | | |
| Idler gear end clearance | | | 0.004 | 0.008 | * |
| Idler gear shaft diameter | 2.2460 | 2.2470 | | | 2.2450 |
| Bearing to shaft clearance | 0.001 | 0.005 | | | * |
| Accessory shaft bearing journal diameter | 2.9995 | 3.0005 | | | 2.9985 |
| Drive shaft end clearance | 0.0025 | 0.0055 | | | |
| Oil Pump Group: | | | | | |
| Drive shaft diameter | 1.2275 | 1.2281 | | | 1.2265 |
| Gear to cover clearance | | | 0.002 | 0.004 | * |
| Gearing bore | 1.2300 | 1.2310 | | | 0.005 |
| Relief valve pressure spring O.D. | 1.063 | - | | | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Camshaft Group: | | | | | |
| Rear bearing journal diameter | 1.8710 | 1.8720 | | | 1.8700 |
| Bearing to journal clearance | | | 0.002 | 0.006 | 0.010 |
| Front and intermediate bearing journal diameters | 2.8750 | 2.8760 | | | |
| Bearing to journal clearance | | | 0.0030 | 0.0080 | 0.010 |
| Camshaft end clearance | | | 0.004 | 0.010 | 0.25 |
| Valve Mechanism Group: | | | | | |
| Valves: | | | | | |
| Outside diameter | 1.476 | - | | | * |
| Stem diameter | 0.3715 | 0.3725 | | | * |
| Guide clearance | | | 0.0019 | 0.0043 | 0.009 |
| Inlet valve lip thickness (minimum) | 0.0716 | | | | * |
| Exhaust valve lip thickness (minimum) | 0.720 | | | | * |
| Inlet valve head diameter | 1.766 | 1.766 | | | * |
| Exhaust valve head diameter | 1.641 | 1.651 | | | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Camshaft Group: (continued) | | | | | |
| Valve guide and seat inserts: | | | | | |
| Valve guide bore | 0.3744 | 0.3758 | | | 0.3734 |
| Guide length | 2.872 | - | | | * |
| Bore depth in head for insert | 0.473 | 0.475 | | | * |
| Diameter of bore in head for insert: | | | | | |
| Inlet | 1.8085 | 1.8095 | | | * |
| Exhaust | 1.6835 | 1.6845 | | | * |
| Insert diameter: | | | | | |
| Inlet | 1.8115 | 1.8125 | | | * |
| Exhaust | 1.6865 | 1.6875 | | | * |
| Valve seat width: | | | | | |
| Inlet | 0.060 | - | | | * |
| Exhaust | 0.074 | - | | | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Camshaft Group: (continued) | | | | | |
| Valve seat diameter: | | | | | |
| Inlet seat (minimum) | 1.714 | - | | | * |
| Inlet seat (maximum) | 1.7456 | | | | * |
| Exhaust seat (minimum) | 1.589 | | | | * |
| Exhaust seat (maximum) | 1.6210 | | | | * |
| Camshaft Drive Group: | | | | | |
| Drivegear rear journal diameter | 2.2465 | 2.2475 | | | 2.2455 |
| Bearing clearance in flywheel housing | | | 0.002 | 0.006 | * |
| Drive gear front journal diameter | 2.9960 | 2.9970 | | | 2.9950 |
| Bearing clearance in cage | | | 0.002 | 0.006 | * |
| End clearance | | | 0.004 | 0.008 | * |
| Idler gear shaft diameter | 1.9970 | 1.9980 | | | * |
| Bearing to shaft clearance | | | 0.002 | 0.006 | * |
| Idler gear end clearance | | | 0.004 | 0.008 | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| **Connecting rods:** | | | | | |
| **Pin bearing bore** | 2.0010 | 2.0015 | | | * |
| **Center to center length** | 11.124 | 11.126 | | | * |
| **Rod bearing bore** | 3.8545 | 3.8555 | | | * |
| **Pin diameter** | 1.9997 | 2.0000 | | | * |
| **Rod bearing clearance** | | | 0.0010 | 0.0018 | 0.006 |
| **Crankshaft journal bearing bore** | 3.5434 | 3.5456 | | | 3.5424 |
| **Journal to bearing clearance** | | | | | |
| **Piston and Rings:** | | | | | |
| **Top ring to groove clearance** | | | 0.0057 | 0.0071 | 0.014 |
| **Intermediate ring to groove clearance** | | | 0.0030 | 0.0048 | * |
| **Oil controlling to groove clearance** | | | 0.0015 | 0.0030 | * |
| **Piston pin bore** | 1.9998 | 2.0004 | | | * |
| **Pin to piston bore clearance** | 0.0003 | 0.0007 | | | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Piston and Rings: (continued) | | | | | |
| Ring gap measured in unworn portion of liner bore (Size 5.400 in.) | | | | | |
| Top ring | 0.019 | 0.029 | | | * |
| Intermediate ring | 0.019 | 0.029 | | | * |
| 0.1 ring | 0.015 | 0.025 | | | * |
| *Increase ring gap for each 0.001 inch increase in liner bore. | | | | | |
| Crankshaft Group: | | | | | |
| End play | | | 0.006 | 0.018 | 0.035 |
| Connecting rod journal diameter | 3.5395 | 3.5405 | | | 3.5385 |
| Connecting rod journal out of round | | | | | 0.003 |
| Main bearing journal diameter | 4.4995 | 4.5005 | | | 4.4985 |
| Main bearing clearance | | | 0.0035 | 0.0066 | 0.010 |
| Cylinder Block: | | | | | |
| Top plate thickness | 0.5145 | 0.5155 | | | 0.5135 |
| Top plate to cylinder block gasket thickness | 0.008 | - | | | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Cylinder Block: (continued) | | | | | |
| Liner projection above top plate liner clamped down | 0.002 | 0.006 | | | * |
| Main bearing bore diameter | 4.8850 | 4.8860 | | | 4.8840 |
| Fuel Burning Heater Coolant Pump: | | | | | |
| Rotor head: | | | | | |
| Diameter | 0.904 | 0.906 | | | * |
| Length | 0.246 | 0.248 | | | * |
| Rotor bore diameter | 0.3033 | 0.3038 | | | * |
| Rotor blade slot width | 0.0935 | 0.0945 | | | * |
| Rotor blade slot depth | 0.263 | 0.268 | | | * |
| Blade: | | | | | |
| Height | 0.247 | 0.249 | | | * |
| Thickness | 0.091 | 0.093 | | | * |
| Width | 0.247 | 0.249 | | | * |
| Adapter bore diameter | 0.315 | 0.318 | | | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Generator: | | | | | |
| Bearing inside diameter | 2.7551 | 2.7559 | | | * |
| Bearing outside diameter | 5.9047 | 5.9055 | | | * |
| Shaft bearing surface diameter | 2.7560 | 2.7565 | | | * |
| Endbell bearing contact surface | 5.9055 | 5.9062 | | | * |
| Fuel Burning Winterization Kit: | | | | | |
| Heater Coolant Pump: | | | | | |
| ROTOR head diameter | 0.904 | 0.906 | | | * |
| ROTOR head length | 0.246 | 0.248 | | | * |
| ROTOR bore diameter | 0.3033 | 0.3038 | | | * |
| Rotor blade slot width | 0.0935 | 0.0945 | | | * |
| Rotor blade slot depth | 0.263 | 0.268 | | | * |
| Blade: | | | | | |
| Height | 0.247 | 0.249 | | | * |
| Thickness | 0.091 | 0.093 | | | * |
| Width | 0.247 | 0.249 | | | * |
| Adapter bore diameter | 0.315 | 0.318 | | | * |
| Relief valve spring free length | | | | | 1.164 |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| **Fuel Burning Winterization Kit: (continued)** | | | | | |
| **Heater Motor Endplay** | | | 0.010 | 0.025 | * |
| **Heater fuel orifice assembly opening** | | | | 0.012 | * |
| **Electric Winterization Kit Coolant Pump:** | | | | | |
| **Relief valve spring free length** | | | | | 1.164 |
| **Seal spring free length** | | | | | 0.470 |
| **Shaft diameter** | 0.3075 | 0.3175 | | | 0.3065 |
| **Rotor head diameter** | 0.904 | 0.906 | | | * |
| **Rotor head length** | 0.246 | 0.248 | | | * |
| **Rotor bore diameter** | 0.3033 | 0.3038 | | | * |
| **Rotor blade slot width** | 0.0935 | 0.0945 | | | * |
| **Rotor blade slot depth** | 0.262 | 0.268 | | | * |
| **Blade:** | | | | | |
| **Height** | 0.247 | 0.249 | | | * |
| **Thickness** | 0.091 | 0.093 | | | * |
| **Width** | 0.247 | 0.249 | | | * |

Table 1-1. Repair and Replacement Standards (continued)

| COMPONENT | MANUFACTURER'S DIMENSIONS AND TOLERANCES IN INCHES | | DESIRED CLEARANCE | | MAXIMUM ALLOWABLE WEAR AND CLEARANCE |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| Electric Winterization Kit Coolant Pump: (continued) | | | | | |
| Adapter bore diameter | 0.315 | 0.318 | | | 0.305 |
| Cam ring bore diameter | 1.000 | 1.002 | | | 0.990 |
| Cam ring width | 0.249 | 0.255 | | | |
| Motor Endplay | | | 0.010 | 0.025 | * |

* - Indicates that the part or parts should be replaced when worn beyond the limits given in the Manufacturer's dimension, tolerances and desired clearance columns.

L - Indicates a loose fit (clearance).

T - Indicates a tight fit (interference).

n. TIME STANDARDS. Table 1-3 lists the number of man-hours required under normal conditions to perform the indicated maintenance and repair for the generator sets. Components are listed under the appropriate functional index. The times listed are not intended to be rigid standards. Under adverse conditions, the operations will take longer, but under ideal conditions with highly skilled mechanics, most of the operations can be accomplished in considerably less time.

o. SCHEMATICS AND WIRING DIAGRAMS. Figures 1-1 through 1-31 show the schematic and wiring diagrams for the 50/60 hertz generator sets, their components and auxiliaries.

Table 1-2. Special Torque Data

| COMPONENT | TORQUE VALUE |
|---|---|
| GENERATOR | |
| Generator Mount to Skid Base Screws | 600 foot pounds |
| Shaft Coupling to Flywheel Mounting Screws | 150 foot pounds |
| Generator Frame to Flywheel Housing Mounting Screws | 75 foot pounds |
| Main Stator Assembly Setscrews | 5 foot pounds |
| Rectifier Assembly Setscrews | 20 foot pounds |
| Spacer Setscrews | 20 foot pounds |
| Shaft Coupling Screws | 50 foot pounds |
| STARTER MOTOR | |
| Intermediate to Pinion Housing Screws | 13 to 17 foot pounds |
| ENGINE | |
| Mounting Screws | 200 foot pounds |
| Valve Cover Screws | 8 ± 2 foot pounds |
| Tachometer Drive Group Mounting Bolts | 8 ± 2 foot pounds |
| Exhaust Manifold Mounting Bolts | 29 to 35 foot pounds |
| Fuel Injection Pump Bushings | 140 to 160 foot pounds |
| Fuel Injection Pump Nozzle Retaining Nuts | 100 to 110 foot pounds |

Table 1-2. Special Torque Data (continued)

| COMPONENT | TORQUE VALUE |
|---|---|
| ENGINE (continued) | |
| Fuel Injection Pump Fuel Line Nuts | 25 to 35 foot pounds |
| Cylinder Head Plugs | 96 to 144 inch pounds |
| Cylinder Head Chamber Assemblies | 145 to 150 foot pounds |
| *Cylinder Head Bolts: | |
| Numerical Sequence (Figure 8-57) (Hand torque only - do not use power tools.) | Step 1. Tighten all bolts to 220 foot pounds.<br>Step 2. Retighten all bolts from 320 to 340 foot pounds.<br>Step 3. Again retighten all bolts from 320 to 340 foot pounds. |
| Connecting Rod Cap Bolts | Step 1. 45 to 55 foot pounds (wet).<br>Step 2. Mark bolt and caps.<br>Step 3. Tighten additional 180° from mark. |
| Accessory Drive Gear Retaining Bolts | 35 to 40 foot pounds |
| Accessory Drive Pump Drive Coupling Bolts | 66 to 74 foot pounds |
| Crankshaft Pulley Bolt | 138 to 159 foot pounds |
| Flywheel Bolts | 230 to 300 foot pounds |
| Water Pump Impeller Nut | 55 foot pounds (plus amount to align cotter pin hole) |
| Oil Pump Gear Retaining Nut | 100 foot pounds (plus amount to align cotter pin hole) |
| Main Bearing Cap Bolts | Step 1. 70 to 80 foot pounds (wet).<br>Step 2. Mark bolts and cap.<br>Step 3. Tighten additional 120° from mark. |
| Turbocharger Wheel Retaining Nut | 150 inch pounds (with shaft heated to 350°F) (when shaft is cooled to less than 150°F) 30 inch pounds (wet) |
| Turbocharger Thrust Plate Bolts | 30 to 40 inch pounds |
| Turbocharger turbine housing bolts | 160 to 190 inch pounds |
| Turbocharger impeller housing bolts | 100 to 110 inch pounds |

*See figure 8-46 for cylinder head tightening sequence.

Table 1-3. Time Standards

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| 03 Generator Set Housing | |
| (to replace) | 6.0 |
| (to repair) | 4.0 |
| Doors | |
| (to repair) | 1.0 |
| Covers | |
| (to repair) | 1.0 |
| Panels | |
| (to repair) | 1.0 |
| 04 Radiator Assembly | |
| (to repair) | 2.0 |
| (to overhaul) | 5.0 |
| Shutters Assembly | |
| (to repair) | 2.0 |
| Radiator | |
| (to test) | 2.0 |
| (to repair) | 2.0 |
| Radiator Core | |
| (to replace) | 3.0 |
| (to repair) | 3.0 |
| 05 Engine Wiring | |
| (to overhaul) | 2.0 |
| Wire Harness | |
| (to rebuild) | 4.0 |
| 06 Generator Control Assembly | |
| (to test) | 3.0 |
| (to adjust) | 1.0 |
| (to replace) | 5.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| (to repair) | 3.0 |
| (to overhaul) | 4.0 |
| (to rebuild) | 4.0 |
| Generator Wire Harness | |
| (to replace) | 1.0 |
| (to rebuild) | 4.0 |
| Control Cubicle Controls and Instrument Panel | |
| (to replace) | 0.50 |
| AC Wattmeter | |
| (to test) | 0.5 |
| AC Ammeter | |
| (to test) | 0.5 |
| Frequency Meter | |
| (to test) | 1.0 |
| Frequency Transducer | |
| (to test) | 0.5 |
| Precise Governor Assembly | |
| (to test) | 0.5 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.5 |
| (to rebuild) | 2.0 |
| Precise Governor Electric Control Unit | |
| (to test) | 1.0 |
| (to adjust) | 0.5 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 3.0 |
| (to rebuild) | 5.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Precise Governor Load Measurement Unit | |
| (to test) | 0.5 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| (to rebuild) | 1.0 |
| Precise Governor Electro-Hydraulic Actuator | |
| (to test) | 0.5 |
| (to adjust) | 0.2 |
| (to replace) | 0.5 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| (to rebuild) | 1.0 |
| Exciter Regulator | |
| (to inspect) | 0.5 |
| (to test) | 1.0 |
| (to adjust) | 0.2 |
| (to replace) | 0.5 |
| (to repair) | 2.0 |
| (to overhaul) | 2.0 |
| (to rebuild) | 2.0 |
| Fault Locating Indicator Box | |
| (to test) | 1.0 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.5 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| DC Circuit Breaker Box | |
| (to test) | 0.2 |
| (to replace) | 0.1 |
| (to repair) | 0.5 |
| (to overhaul) | 0.5 |
| Tactical Relay Box | |
| (to replace) | 0.2 |
| (to repair) | 2.0 |
| (to overhaul) | 2.0 |
| Over Voltage Relay | |
| (to test) | 0.5 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| Reverse Power Relay | |
| (to test) | 0.2 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| Short Circuit Relay | |
| (to test) | 0.2 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Precise Relay Box | |
| (to replace) | 0.5 |
| (to repair) | 2.0 |
| (to overhaul) | 2.0 |
| Under Voltage Relay | |
| (to test) | 0.2 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| Under Frequency Relay (50/60 Hertz) | |
| (to test) | 0.5 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| Permissive Paralleling Relay | |
| (to test) | 0.5 |
| (to adjust) | 0.2 |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| Mode I Relay Box | |
| (to test) | 1.0 |
| (to adjust) | 0.2 |
| (to replace) | 0.5 |
| (to repair) | 2.0 |
| (to overhaul) | 2.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Circuit Breaker Assembly, Current Transformer, and Load and Reconnection Terminal Boards | |
| (to test) | 0.2 |
| (to replace) | 4.0 |
| (to repair) | 2.5 |
| (to overhaul) | 3.0 |
| Convenience Receptacle Box | |
| (to replace) | 0.2 |
| (to repair) | 0.5 |
| (to overhaul) | 0.5 |
| 07 Generator Assembly | |
| (to test) | 3.0 |
| (to replace) | 4.0 |
| (to repair) | 4.0 |
| (to overhaul) | 40.0 |
| (to rebuild) | 40.0 |
| Bearing | |
| (to replace) | 2.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Rotating Rectifier | |
| (to inspect) | 1.0 |
| (to test) | 1.5 |
| (to replace) | 2.0 |
| (to repair) | 2.0 |
| (to overhaul) | 2.0 |
| Generator Fan | |
| (to inspect) | 1.0 |
| (to replace) | 4.0 |
| Rotor Assembly | |
| (to inspect) | 2.0 |
| (to test) | 1.0 |
| (to replace) | 4.0 |
| (to repair) | 20.0 |
| (to overhaul) | 20.0 |
| (to rebuild) | |
| Exciter Rotor | |
| (to inspect) | 2.0 |
| (to test) | 1.0 |
| (to repair) | 8.0 |
| (to replace) | 4.0 |
| (to overhaul) | 20.0 |
| (to rebuild) | 20.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Main Stator Assembly | |
| (to inspect) | 1.0 |
| (to test) | 1.0 |
| (to replace) | 4.0 |
| (to repair) | 20.0 |
| (to overhaul) | 20.0 |
| (to rebuild) | 20.0 |
| Exciter Stator | |
| (to inspect) | 1.0 |
| (to test) | 1.0 |
| (to replace) | 4.0 |
| (to repair) | 20.0 |
| (to overhaul) | 20.0 |
| (to rebuild) | 20.0 |
| 08 Engine | |
| Engine Assembly | |
| (to replace) | 6.0 |
| (to repair) | 15.0 |
| (to overhaul) | 30.0 |
| (to rebuild) | 106 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Alternator Assembly | |
| (to repair) | 1.0 |
| (to overhaul) | 2.0 |
| (to rebuild) | 4.0 |
| Diodes | |
| (to inspect) | 0.2 |
| (to test) | 0.5 |
| (to replace) | 1.0 |
| Rotor | |
| (to test) | 0.5 |
| (to replace) | 0.5 |
| (to overhaul) | 2.0 |
| Starter Assembly | |
| (to repair) | 2.0 |
| (to overhaul) | 8.0 |
| (to rebuild) | 10.0 |
| Starter Solenoid | |
| (to replace) | 1.0 |
| Starter Armature | |
| (to test) | 1.0 |
| (to replace) | 1.0 |
| (to repair) | 3.0 |
| (to overhaul) | 6.0 |
| Starter Drive | |
| (to replace) | 1.0 |
| (to repair) | 1.0 |
| Field Assembly | |
| (to test) | 1.0 |
| (to replace) | 1.0 |
| (to repair) | 3.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Fan Mounting Group | |
| (to replace) | 0.4 |
| (to repair) | 0.1 |
| Day Tank Assembly | |
| (to adjust) | 0.5 |
| (to repair) | 1.0 |
| Overspeed Governor Switch | |
| (to adjust) | 0.5 |
| (to repair) | 1.0 |
| (to overhaul) | 2.0 |
| (to rebuild) | 2.0 |
| Tachometer Drive | |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| Fuel Pump Group | |
| (to replace) | 0.4 |
| (to repair) | 0.4 |
| Turbocharger Group | |
| (to repair) | 2.4 |
| (to overhaul) | 2.5 |
| (to rebuild) | 3.3 |
| Oil Cooler Group | |
| (to replace) | 2.0 |
| (to repair) | 4.0 |
| Water Pump Group | |
| (to repair) | 1.2 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Hydraulic Oil Tank Assembly (used on Precise Generator Sets only) | |
| (to replace) | 0.5 |
| (to repair) | 1.0 |
| Hydraulic Pump (used on Precise Generator Sets only) | |
| (to test) | 1.0 |
| (to replace) | 0.5 |
| (to repair) | 0.5 |
| (to overhaul) | 1.0 |
| (to rebuild) | 2.0 |
| (to adjust) | 0.5 |
| Hydraulic Pump Drive Group | |
| (to replace) | 0.2 |
| (to repair) | 1.0 |
| (to overhaul) | 1.2 |
| Crankshaft Pulley | 0.5 |
| (to replace) | |
| Damper | |
| (to replace) | 3.0 |
| Timing Gear Cover | |
| (to replace) | 4.0 |
| Timing Gears | |
| (to replace) | 4.5 |
| Utility Governor Group | |
| (to test) | 0.5 |
| (to replace) | 0.5 |
| (to repair) | 1.0 |
| (to overhaul) | 3.0 |
| (to rebuild) | 4.0 |
| (to adjust) | 0.5 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Governor Linkage | |
| (to replace) | 1.0 |
| (to repair) | 1.0 |
| (to adjust) | 0.2 |
| Fuel Injection Lines | |
| (to replace) | 0.5 |
| Valve Assemblies | |
| (to test) | 1.0 |
| (to replace) | 4.0 |
| (to repair) | 6.0 |
| (to overhaul) | 6.0 |
| (to adjust) | 0.5 |
| Injection Pump | |
| (to test) | 2.0 |
| (to replace) | 0.4 |
| (to repair) | 6.0 |
| (to overhaul) | 8.0 |
| (to rebuild) | 10.0 |
| Accessory Drive Group | |
| (to replace) | 0.7 |
| (to repair) | 1.0 |
| (to overhaul) | 1.2 |
| Exhaust Manifold Group | |
| (to replace) | 1.9 |
| Oil Pan Group | |
| (to replace) | 0.9 |
| (to repair) | 0.1 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Oil Pump Group | |
| (to test) | 0.3 |
| (to replace) | 1.0 |
| (to repair) | 1.5 |
| Valve Mechanism Group | |
| (to replace) | 0.5 |
| (to repair) | 0.8 |
| Arm Assemblies | |
| (to replace) | 0.5 |
| (to adjust) | 0.6 |
| Cylinder Head Group | |
| (to replace) | 5.0 |
| (to repair) | 2.0 |
| (to overhaul) | 4.0 |
| (to rebuild) | 4.0 |
| Intake and Exhaust Valves | |
| (to test) | 0.5 |
| (to replace) | 1.6 |
| (to repair) | 2.0 |
| Valve Springs | |
| (to test) | 1.0 |
| (to replace) | 1.6 |
| Intake and Exhaust Valve Inserts | |
| (to replace) | 1.2 |
| Valve Guides | |
| (to replace) | 2.4 |
| Flywheel and Flywheel Housing Group | |
| (to replace) | 2.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Flywheel | |
| (to replace) | 0.3 |
| Flywheel Ring Gear | |
| (to replace) | 0.9 |
| Flywheel Housing | |
| (to replace) | 1.7 |
| Camshaft Group | |
| (to replace) | 7.0 |
| Connecting Rods and Pistons Group | |
| (to replace) | 6.0 |
| Connecting Rod | |
| (to replace) | 0.2 |
| Rod Bearings | |
| (to replace) | 0.4 |
| Piston Pins | |
| (to replace) | 0.2 |
| Piston Rings | |
| (to replace) | 0.5 |
| Crankshaft Group and Main Bearings | |
| (to replace) | 5.0 |
| Cylinder Block | |
| (to replace) | 48.0 |
| Cylinder Sleeves | |
| (to replace) | 0.5 |
| 09 Fuel Burning Winterization Kit, Regular (per Heater) | |
| (to repair) | 1.0 |
| (to overhaul) | 2.0 |
| Heater Control Assembly | |
| (to repair) | 0.5 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Valve | |
| (to inspect) | 0.2 |
| (to replace) | 0.5 |
| Nozzle | |
| (to inspect) | 0.5 |
| (to replace) | 0.5 |
| Terminal Board | |
| (to replace) | 0.2 |
| Switch | |
| (to replace) | 0.2 |
| Burner Assembly | |
| (to replace) | 0.5 |
| (to repair) | 0.5 |
| Head Assembly | |
| (to inspect) | 0.5 |
| (to replace) | 1.0 |
| Blower Assembly | |
| (to replace) | 1.0 |
| (to repair) | 2.0 |
| Fan Motor Assembly | |
| (to replace) | 1.0 |
| (to repair) | 1.0 |
| Fan | |
| (to replace) | 1.0 |
| Motor | |
| (to replace) | 0.5 |
| Coolant Pump | |
| (to replace) | 1.0 |
| (to repair) | 2.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| 10 Sub Base Assembly | |
| (to replace) | 6.0 |
| (to repair) | 2.0 |
| Main Fuel Tank | |
| (to replace) | 1.0 |
| (to repair) | 2.0 |
| Fuel Transmitter | |
| (to test) | 0.5 |
| (to replace) | 1.0 |
| 11 Fuel Burning Winterization Kits | |
| (to replace) | 1.0 |
| (to repair) | 2.0 |
| (to overhaul) | 3.0 |
| (to rebuild) | 3.0 |
| Fuel Pumps | |
| (to repair) | 1.0 |
| Control Assembly | |
| (to repair) | 1.0 |
| Terminal Board | |
| (to replace) | 0.5 |
| Heater Relay | |
| (to test) | 0.5 |
| (to replace) | 0.2 |
| Wire Harness | |
| (to rebuild) | 2.0 |
| Flame Switch | |
| (to replace) | 0.5 |
| Burner Assembly | |
| (to replace) | 1.0 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| Blower Assembly | |
| (to replace) | 1.0 |
| (to repair) | 1.0 |
| 12 Electric Winterization Kit | |
| (to overhaul) | 1.0 |
| (to rebuild) | 1.0 |
| Heater Assembly | |
| (to replace) | 1.0 |
| (to repair) | 1.0 |
| (to overhaul) | 1.0 |
| Coolant Pumps | |
| (to replace) | 1.0 |
| (to repair) | 1.0 |
| Heat Exchange (Coil) | |
| (to inspect) | 0.2 |
| (to test) | 0.2 |
| (to replace) | 0.5 |
| (to repair) | 1.0 |
| Transformer | |
| (to test) | 0.2 |
| (to replace) | 0.2 |
| Semi-Conductors | |
| (to inspect) | 0.2 |
| (to test) | 0.1 |
| (to replace) | 0.5 |

Table 1-3. Time Standards (continued)

| MAINTENANCE OPERATIONS | MAN-HOURS |
|---|---|
| 14 Load Bank | |
| (to test) | 1.0 |
| (to repair) | 3.0 |
| (to overhaul) | 6.0 |
| Wire Harness | |
| (to rebuild) | 4.0 |

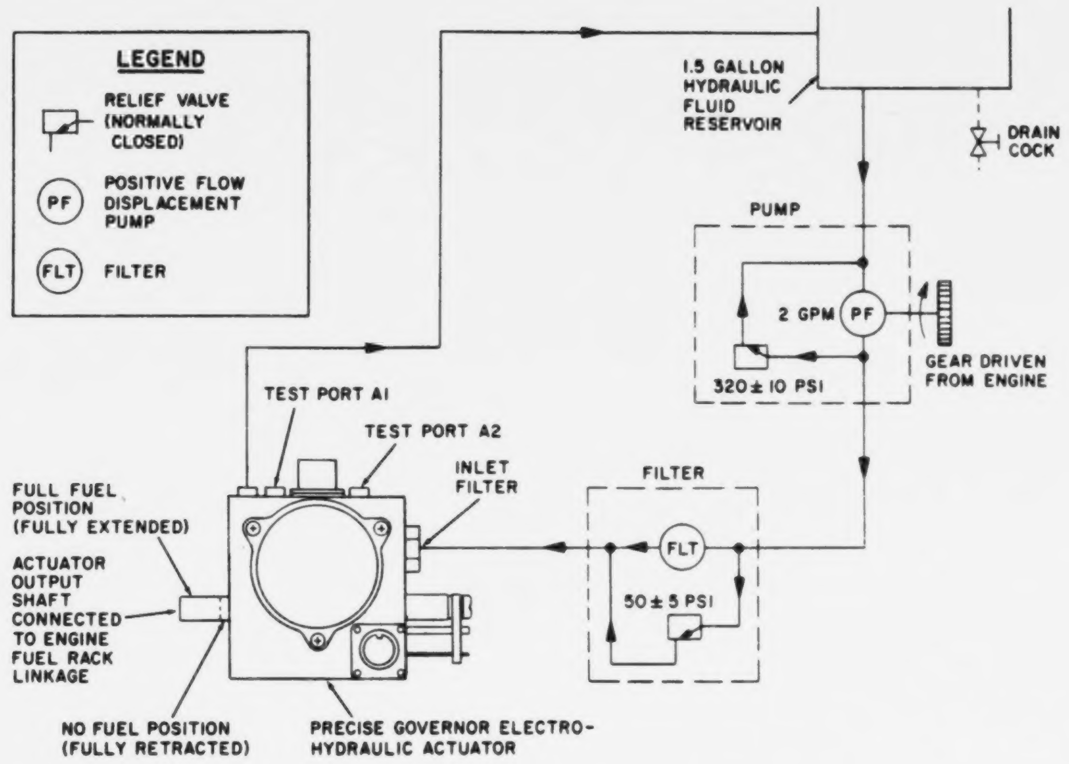
LEGEND
RELIEF VALVE (NORMALLY CLOSED)
PF
POSITIVE FLOW DISPLACEMENT PUMP
FLT
FILTER
1.5 GALLON HYDRAULIC FLUID RESERVOIR
DRAIN COCK
PUMP
2 GPM
PF
GEAR DRIVEN FROM ENGINE
320 ± 10 PSI
TEST PORT A1
TEST PORT A2
INLET FILTER
FILTER
FLT
50 ± 5 PSI
FULL FUEL POSITION (FULLY EXTENDED)
ACTUATOR OUTPUT SHAFT CONNECTED TO ENGINE FUEL RACK LINKAGE
NO FUEL POSITION (FULLY RETRACTED)
PRECISE GOVERNOR ELECTRO-HYDRAULIC ACTUATOR

Figure 1-1. Hydraulic system schematic, precise generator sets

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End of Volume.

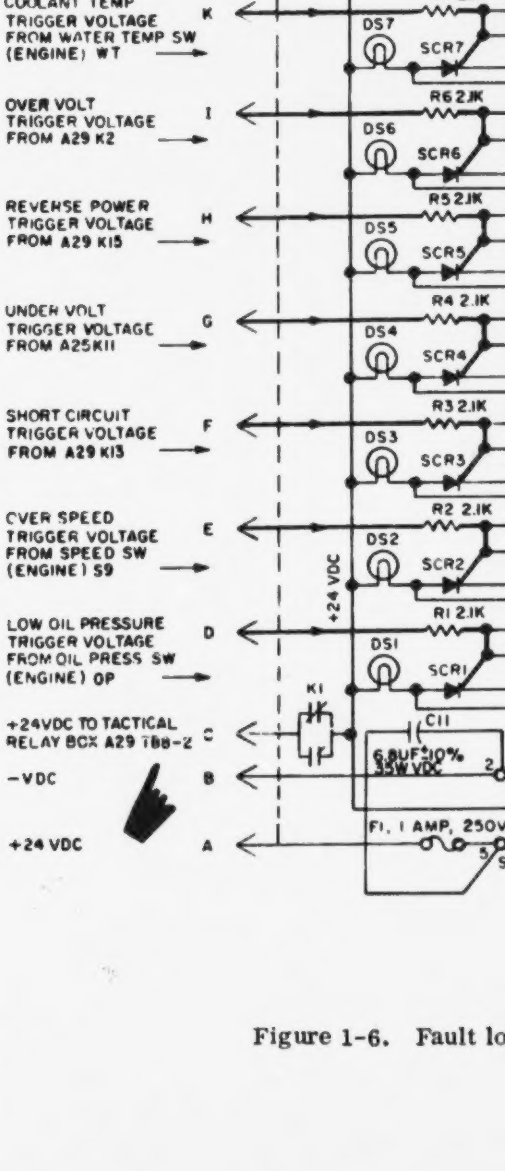
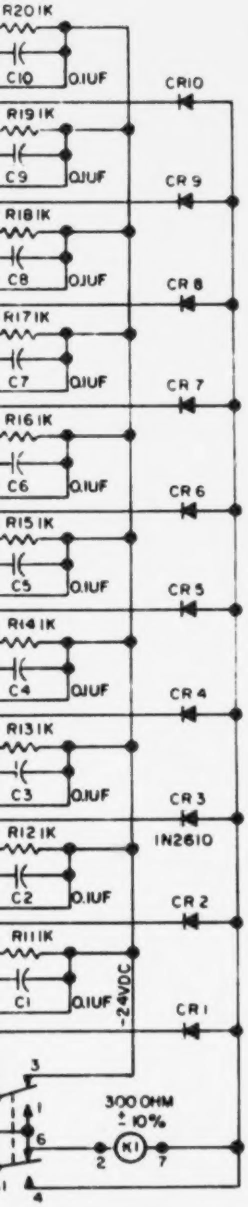

UNDER FREQ TRIGGER VOLTAGE FROM A25K12
OVERLOAD TRIGGER VOLTAGE FROM A29 K14
NO FUEL TRIGGER VOLTAGE FROM A27 A5 K8
COOLANT TEMP TRIGGER VOLTAGE FROM WATER TEMP SW (ENGINE) WT
OVER VOLT TRIGGER VOLTAGE FROM A29 K2
REVERSE POWER TRIGGER VOLTAGE FROM A29 K15
UNDER VOLT TRIGGER VOLTAGE FROM A25K11
SHORT CIRCUIT TRIGGER VOLTAGE FROM A29 K13
OVER SPEED TRIGGER VOLTAGE FROM SPEED SW (ENGINE) S9
LOW OIL PRESSURE TRIGGER VOLTAGE FROM OIL PRESS SW (ENGINE) OP
+24VDC TO TACTICAL RELAY BOX A29 TB8-2
-VDC
+24 VDC
J12
N
M
L
K
I
H
G
F
E
D
C
B
A
R10 2.1K
R9 2.1K
R8 2.1K
R7 2.1K
R6 2.1K
R5 2.1K
R4 2.1K
R3 2.1K
R2 2.1K
R1 2.1K
DS10
DS9
DS8
DS7
DS6
DS5
DS4
DS3
DS2
DS1
SCR10
SCR9
SCR8
SCR7
SCR6
SCR5
SCR4
SCR3
SCR2
SCR1
+24 VDC
K1
C11
6.8UF±10% 35W VDC
2
F1, 1 AMP, 250V
5

Figure 1-6. Fault lo


R20 1K
C10
0.1UF
CR10
R19 1K
C9
0.1UF
CR 9
R18 1K
C8
0.1UF
CR 8
R17 1K
C7
0.1UF
CR 7
R16 1K
C6
0.1UF
CR 6
R15 1K
C5
0.1UF
CR 5
R14 1K
C4
0.1UF
CR 4
R13 1K
C3
0.1UF
CR 3
1N2610
R12 1K
C2
0.1UF
CR 2
R11 1K
C1
0.1UF
-24VDC
CR 1
3
1
6
4
300 OHM
± 10%
K1
2
7

NOTES

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, ±10%, 1/2 WATT

2. UNLESS OTHERWISE SPECIFIED, ALL CAPACITORS ARE ±10%, 200 VDC

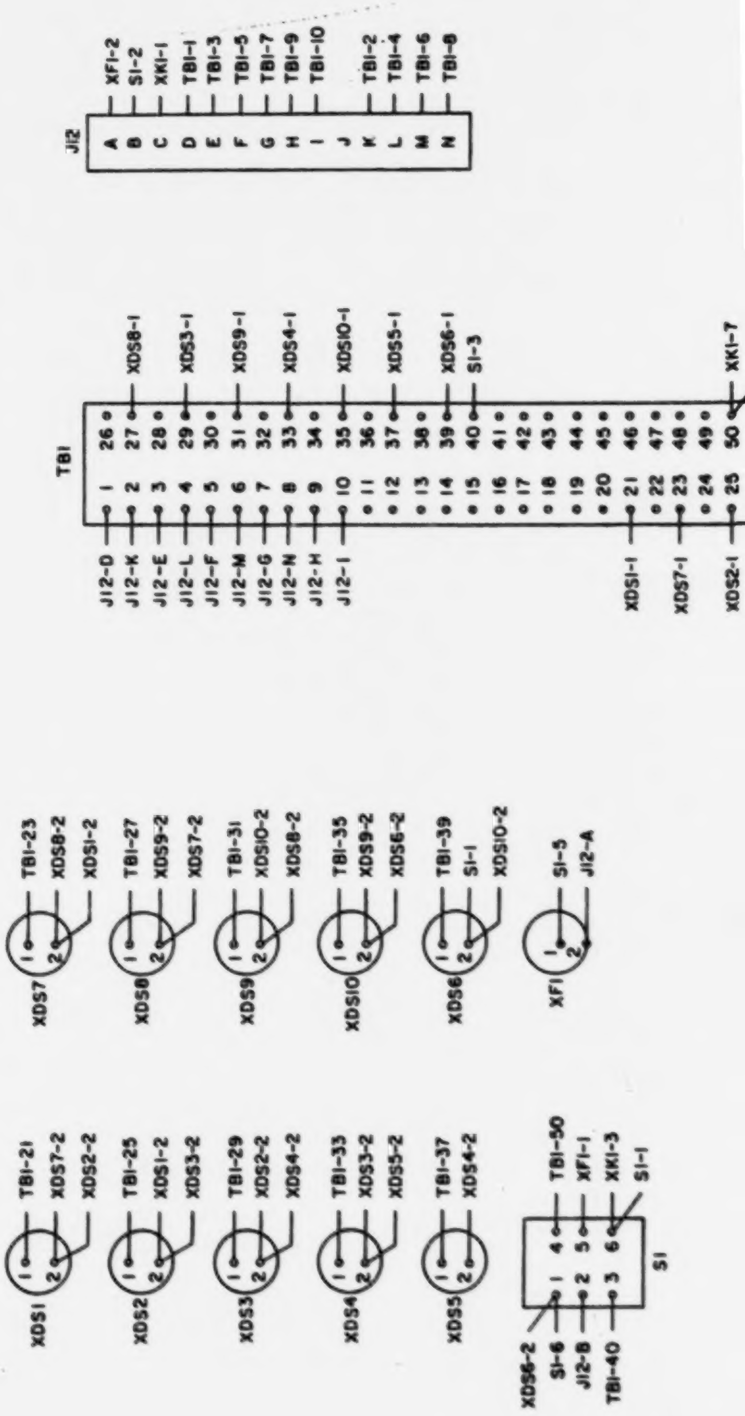
3. DS1 THRU DS10, LAMP, INCANDESCENT, 0.04 AMPS, 24 VOLTS, 96 WATTS

4. ALL VOLTAGES MEASURED TO -VDC UNLESS OTHERWISE SPECIFIED.

5. ALL VOLTAGE MEASUREMENTS ARE MADE WITH A 20,000 OHM PER VOLT METER.

| REF DES | DESCRIPTION |
|---|---|
| C1 THRU C10 | CAPACITOR |
| C11 | CAPACITOR |
| CR1 THRU CR10 | DIODES |
| DS1 THRU DS10 | LAMP INCANDESCENT |
| F1 | FUSE |
| J12 | CONNECTOR, FAULT LOCATING ASSY (A9) |
| K1 | RELAY |
| R1 THRU R10 | RESISTOR |
| R11 THRU R20 | RESISTOR |
| S1 | SWITCH, FAULT RESET |
| SCR1 THRU SCR10 | SILICON CONTROL RECTIFIER |

cating indicator (A9) schematic


J12
A XF1-2
B S1-2
C XK1-1
D TB1-1
E TB1-3
F TB1-5
G TB1-7
H TB1-9
I TB1-10
J
K TB1-2
L TB1-4
M TB1-6
N TB1-8
TB1
J12-D 1
J12-K 2
J12-E 3
J12-L 4
J12-F 5
J12-M 6
J12-G 7
J12-N 8
J12-H 9
J12-I 10
11
12
13
14
15
16
17
18
19
20
XDS1-1 21
22
XDS7-1 23
24
XDS2-1 25
26
27 XDS8-1
28
29 XDS3-1
30
31 XDS9-1
32
33 XDS4-1
34
35 XDS10-1
36
37 XDS5-1
38
39 XDS6-1
40 S1-3
41
42
43
44
45
46
47
48
49
50 XK1-7
XDS7 1 2 TB1-23 XDS8-2 XDS1-2
XDS8 1 2 TB1-27 XDS9-2 XDS7-2
XDS9 1 2 TB1-31 XDS10-2 XDS8-2
XDS10 1 2 TB1-35 XDS9-2 XDS6-2
XDS6 1 2 TB1-39 S1-1 XDS10-2
XF1 1 2 S1-5 J12-A
XDS1 1 2 TB1-21 XDS7-2 XDS2-2
XDS2 1 2 TB1-25 XDS1-2 XDS3-2
XDS3 1 2 TB1-29 XDS2-2 XDS4-2
XDS4 1 2 TB1-33 XDS3-2 XDS5-2
XDS5 1 2 TB1-37 XDS4-2
S1
XDS6-2 S1-6 1 4 TB1-50
J12-B 2 5 XF1-1
TB1-40 3 6 XK1-3 S1-1

| REF DES | DESCRIPTION |
|---|---|
| J12 | CONNECTOR, RECEPTACLE |
| S1 | SWITCH, TOGGLE |
| TB1 | TERMINAL BOARD |
| XDS1 THRU XDS10 | LIGHT, INDICATOR, SOCKET |
| XF1 | FUSEHOLDER |
| XK1 | RELAY SOCKET |

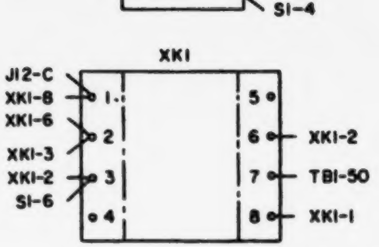
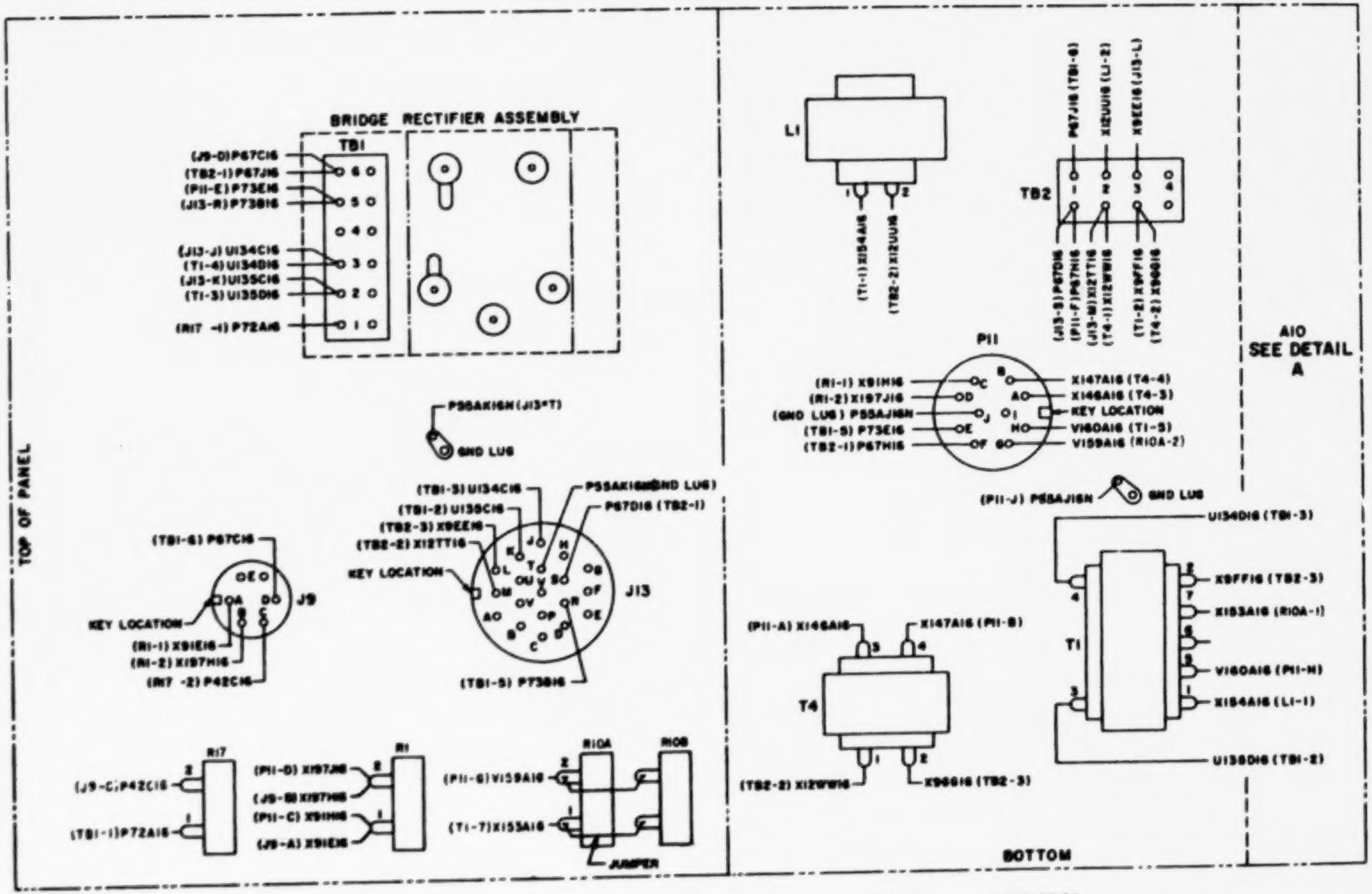

SI-4
XKI
JI2-C
XKI-8
XKI-6
XKI-3
XKI-2
SI-6
1
2
3
4
5
6
7
8
XKI-2
TBI-50
XKI-I

Figure 1-7. Fault locating indicator (A9) wiring diagram


BRIDGE RECTIFIER ASSEMBLY
TB1
(J9-D)P67C16
(TB2-1)P67J16
(P11-E)P73E16
(J13-R)P73B16
(J13-J) U134C16
(T1-4) U134D16
(J13-K)U135C16
(T1-3) U135D16
(R17 -1) P72A16
6
5
4
3
2
1
P55AK16N(J13*T)
GND LUG
TOP OF PANEL
(TB1-6) P67C16
J9
KEY LOCATION
(R1-1) X91E16
(R1-2) X197H16
(R17 -2) P42C16
(TB1-3) U134C16
(TB1-2) U135C16
(TB2-3) X9EE16
(TB2-2) X12TT16
KEY LOCATION
P55AK16(GND LUG)
P67D16 (TB2-1)
J13
(TB1-5) P73B16
R17
(J9-C)P42C16
(TB1-1)P72A16
R1
(P11-D) X197J16
(J9-B) X197H16
(P11-C) X91H16
(J9-A) X91E16
R10A
R10B
(P11-G)V159A16
(T1-7)X153A16
JUMPER
L1
(T1-1) X154A16
(TB2-2) X12UU16
TB2
P67J16 (TB1-6)
X12UU16 (L1-2)
X9EE16 (J13-L)
(J13-S) P67D16
(P11-F)P67H16
(J13-M)X12TT16
(T4-1)X12WW16
(T1-2) X9FF16
(T4-2) X96G16
P11
(R1-1) X91H16
(R1-2)X197J16
(GND LUG) P55AJ16N
(TB1-5) P73E16
(TB2-1)P67H16
X147A16 (T4-4)
X146A16 (T4-3)
KEY LOCATION
V160A16 (T1-5)
V159A16 (R10A-2)
A10
SEE DETAIL
A
(P11-J) P55AJ16N
GND LUG
U134D16 (TB1-3)
X9FF16 (TB2-3)
X153A16 (R10A-1)
V160A16 (P11-H)
X154A16 (L1-1)
U135D16 (TB1-2)
T1
T4
(P11-A) X146A16
X147A16 (P11-B)
(TB2-2) X12WW16
X96G16 (TB2-3)
BOTTOM

| REF DES | DESCRIPTION |
|---|---|
| A10 | VOLTAGE REGULATOR |
| A10 A1 | VOLTAGE REGULATOR, SUBASSEMBLY |
| A10 A2 | VOLTAGE REGULATOR, COMPONENT BOARD ASSEMBLY |
| A10 J11 | CONNECTOR, RECEPTACLE |
| A10 Q3 | TRANSISTOR |
| A10 Q4 | TRANSISTOR |
| A10 R31 | RESISTOR, VARIABLE |
| A10 R32 | RESISTOR, VARIABLE |
| A10 R33 | RESISTOR, VARIABLE |
| A10 TB1 | TERMINAL BOARD |
| A10 TB2 | TERMINAL BOARD |
| A11 | EXCITER ASSEMBLY |
| A11 J9 | CONNECTOR, RECEPTACLE |
| A11 J13 | CONNECTOR, RECEPTACLE |
| A11 L1 | CHOKE |
| A11 P11 | CONNECTOR, RECEPTACLE |
| A11 R1 | RESISTOR, FIXED |
| A11 R10A, R10B | RESISTOR, FIXED |
| A11 R17 | RESISTOR, FIXED |
| A11 T1 | TRANSFORMER |
| A11 T4 | TRANSFORMER |
| A11 TB1 | TERMINAL BOARD, BRIDGE RECTIFIER |
| A11 TB2 | TERMINAL BOARD, EXCITER |

Figure 1-9. Exciter regulator (A10 and A11) 50/60 Hertz wiring diagram (sheet 1 of 2)

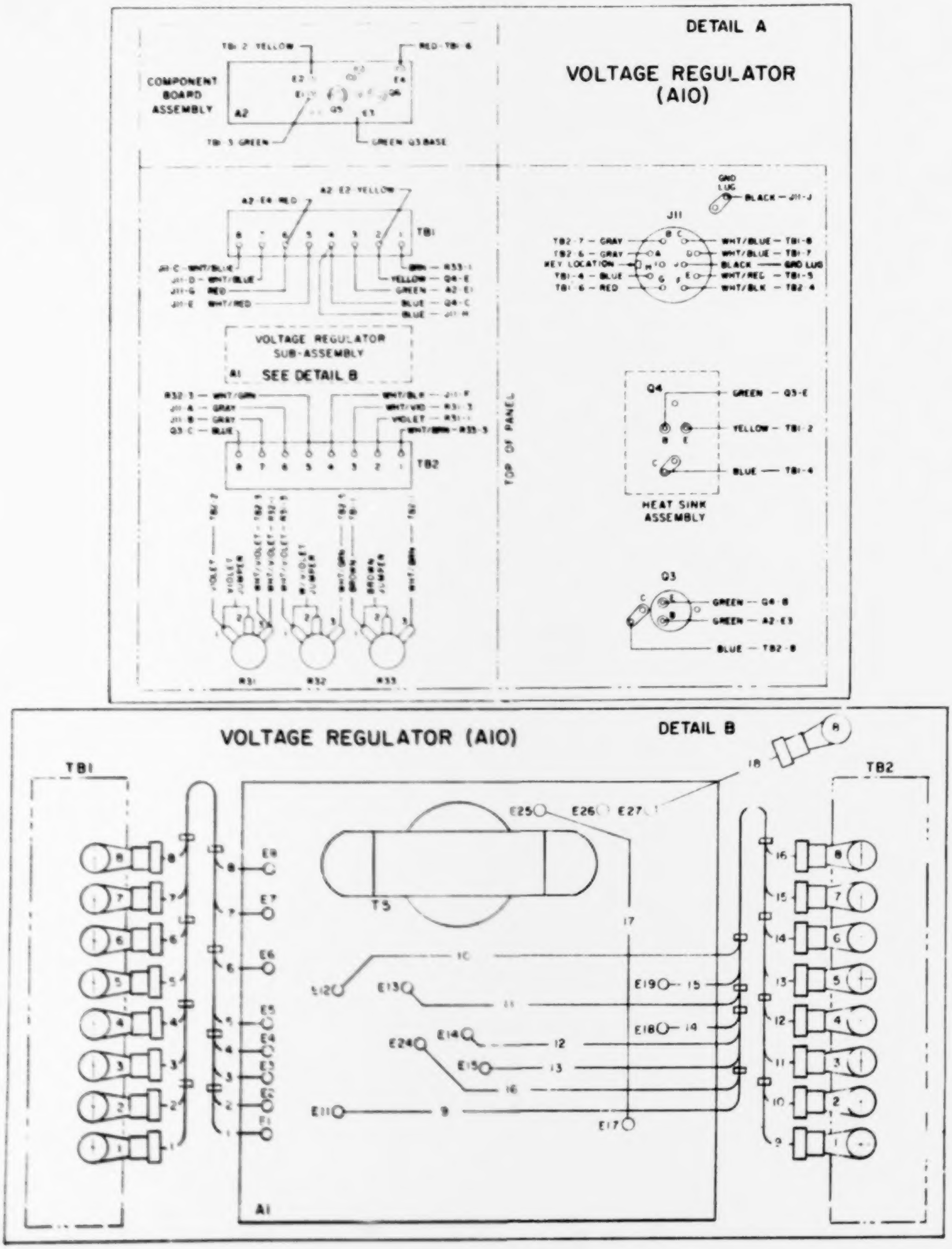
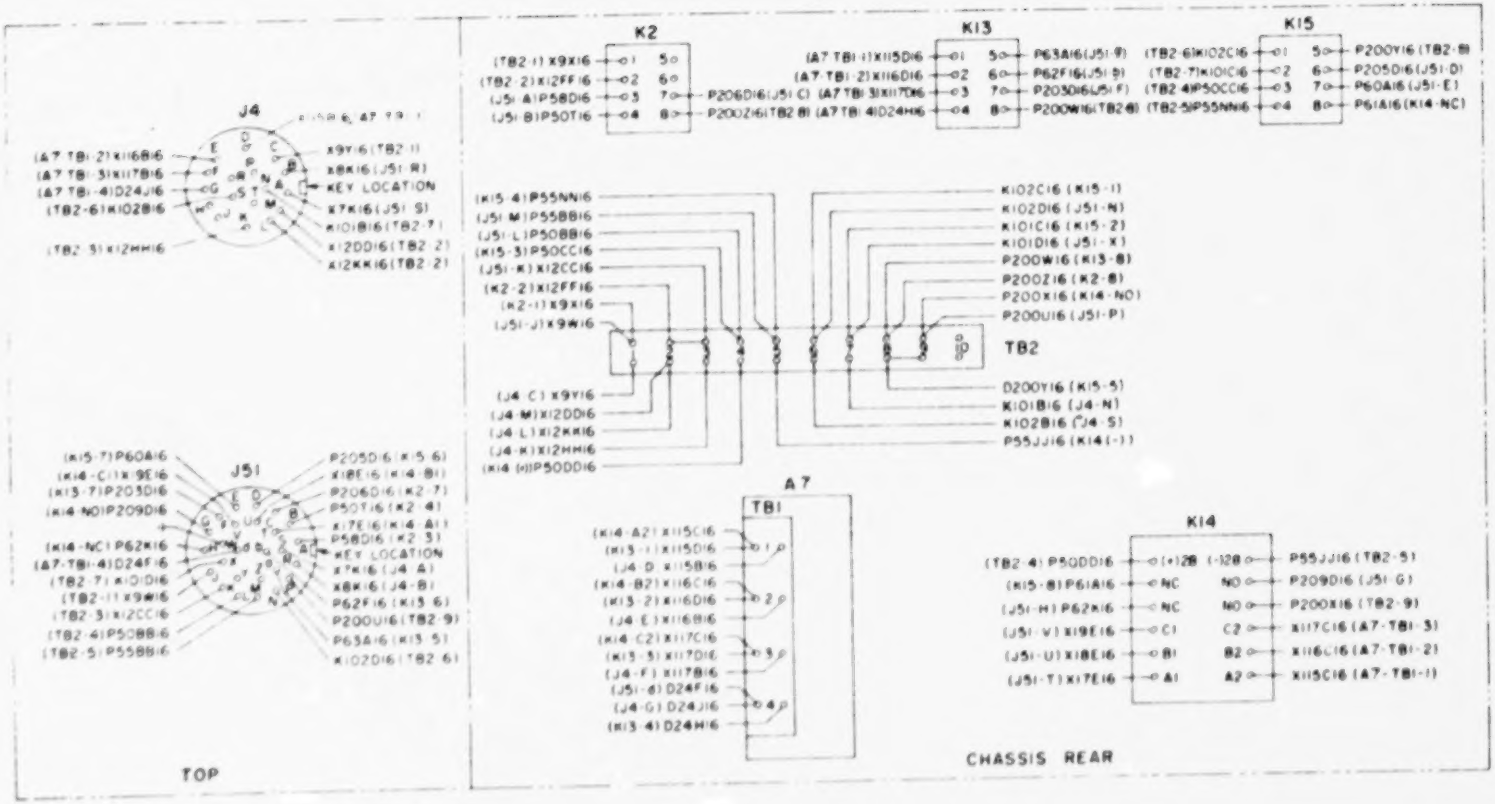
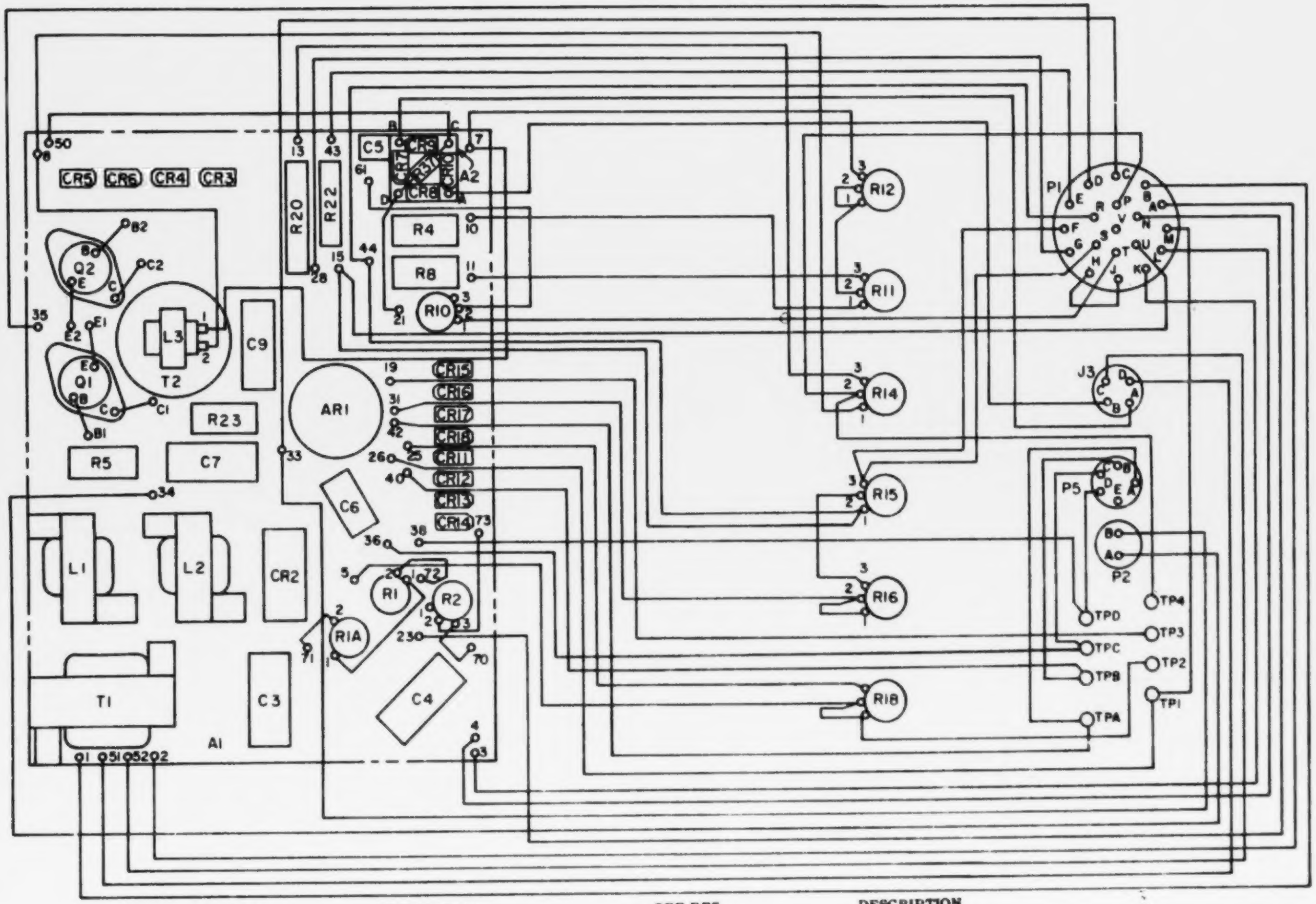

DETAIL A
VOLTAGE REGULATOR (A10)
COMPONENT BOARD ASSEMBLY
A2
TB1-2 YELLOW
RED-TB1-6
TB1-3 GREEN
GREEN Q3 BASE
A2-E4 RED
A2-E2 YELLOW
TB1
J11-C — WHT/BLUE
J11-D — WHT/BLUE
J11-G RED
J11-E WHT/RED
BRN — R33-1
YELLOW — Q4-E
GREEN — A2-E1
BLUE — Q4-C
BLUE — J11-H
VOLTAGE REGULATOR SUB-ASSEMBLY
A1 SEE DETAIL B
R32-3 — WHT/GRN
J11-A — GRAY
J11-B — GRAY
Q3-C — BLUE
WHT/BLK — J11-F
WHT/VIO — R31-3
VIOLET — R31-1
WHT/BRN — R33-3
TB2
TOP OF PANEL
R31
R32
R33
GND LUG
BLACK — J11-J
J11
TB2-7 — GRAY
TB2-6 — GRAY
KEY LOCATION
TB1-4 — BLUE
TB1-6 — RED
WHT/BLUE — TB1-8
WHT/BLUE — TB1-7
BLACK — GND LUG
WHT/RED — TB1-5
WHT/BLK — TB2-4
Q4
GREEN — Q3-E
YELLOW — TB1-2
BLUE — TB1-4
HEAT SINK ASSEMBLY
Q3
GREEN — Q4-B
GREEN — A2-E3
BLUE — TB2-8
VOLTAGE REGULATOR (A10)
DETAIL B
TB1
TB2
T5
A1
E1
E2
E3
E4
E5
E6
E7
E8
E11
E12
E13
E14
E15
E17
E18
E19
E24
E25
E26
E27

Figure 1-9. Exciter regulator (A10 and A11) 50/60 Hertz wiring diagram (sheet 2 of 2)


J4
(A7 TB1-2)X116B16
(A7 TB1-3)X117B16
(A7 TB1-4)D24J16
(TB2-6)X102B16
(TB2-3)X12HH16
X9Y16(TB2-1)
X8K16(J51-R)
KEY LOCATION
X7K16(J51-S)
X101B16(TB2-7)
X12DD16(TB2-2)
X12KK16(TB2-2)
K2
(TB2-1)X9X16
(TB2-2)X12FF16
(J51-A)P58D16
(J51-B)P50T16
P206D16(J51-C)
P200Z16(TB2-8)
K13
(A7 TB1-1)X115D16
(A7 TB1-2)X116D16
(A7 TB1-3)X117D16
(A7 TB1-4)D24H16
P63A16(J51-9)
P62F16(J51-9)
P203D16(J51-F)
P200W16(TB2-8)
K15
(TB2-6)X102C16
(TB2-7)X101C16
(TB2-4)P50CC16
(TB2-5)P55NN16
P200Y16(TB2-8)
P205D16(J51-D)
P60A16(J51-E)
P61A16(K14-NC)
(K15-4)P55NN16
(J51-M)P55BB16
(J51-L)P50BB16
(K15-3)P50CC16
(J51-K)X12CC16
(K2-2)X12FF16
(K2-1)X9X16
(J51-J)X9W16
(J4-C)X9Y16
(J4-M)X12DD16
(J4-L)X12KK16
(J4-K)X12HH16
(K14(+))P50DD16
K102C16 (K15-1)
K102D16 (J51-N)
K101C16 (K15-2)
K101D16 (J51-X)
P200W16 (K13-8)
P200Z16 (K2-8)
P200X16 (K14-NO)
P200U16 (J51-P)
TB2
D200Y16 (K15-5)
K101B16 (J4-N)
K102B16 (J4-S)
P55JJ16 (K14(-))
J51
(K15-7)P60A16
(K14-C1)X19E16
(K13-7)P203D16
(K14-NO)P209D16
(K14-NC)P62K16
(A7-TB1-4)D24F16
(TB2-7)X101D16
(TB2-1)X9W16
(TB2-3)X12CC16
(TB2-4)P50BB16
(TB2-5)P55BB16
P205D16(K15-6)
X18E16(K14-B1)
P206D16(K2-7)
P50T16(K2-4)
X17E16(K14-A1)
P58D16(K2-3)
KEY LOCATION
X7K16(J4-A)
X8K16(J4-B)
P62F16(K13-6)
P200U16(TB2-9)
P63A16(K13-5)
X102D16(TB2-6)
A7
TB1
(K14-A2)X115C16
(K13-1)X115D16
(J4-D)X115B16
(K14-B2)X116C16
(K13-2)X116D16
(J4-E)X116B16
(K14-C2)X117C16
(K13-3)X117D16
(J4-F)X117B16
(J51-d)D24F16
(J4-G)D24J16
(K13-4)D24H16
K14
(TB2-4)P50DD16
(K15-8)P61A16
(J51-H)P62K16
(J51-V)X19E16
(J51-U)X18E16
(J51-T)X17E16
(+)28
(-)28
NC
NO
C1
C2
B1
B2
A1
A2
P55JJ16(TB2-5)
P209D16(J51-G)
P200X16(TB2-9)
X117C16(A7-TB1-3)
X116C16(A7-TB1-2)
X115C16(A7-TB1-1)
TOP
CHASSIS REAR

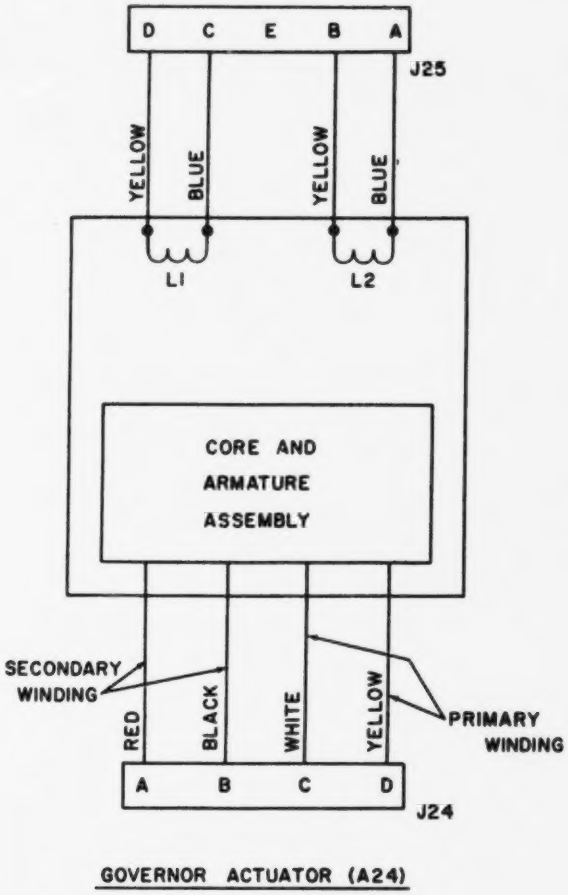
| REF DES | DESCRIPTION | REF DES | DESCRIPTION |
|---|---|---|---|
| A7 | CURRENT TRANSFORMER, LOAD RESISTOR ASSEMBLY | K2 | RELAY, OVER VOLTAGE |
| J4 | CONNECTOR, RECEPTACLE | K13 | RELAY, SHORT CIRCUIT |
| J51 | CONNECTOR, RECEPTACLE | K15 | RELAY, REVERSE POWER |
| | | TB2 | TERMINAL BOARD |

Figure 1-13. Tactical relay box (A29) wiring diagram


A1
A2
AR1
C3
C4
C5
C6
C7
C9
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR9
CR10
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR18
L1
L2
L3
Q1
Q2
R1
R1A
R2
R4
R5
R8
R10
R11
R12
R14
R15
R16
R18
R20
R22
R23
T1
T2
P1
P2
P5
J3
TP1
TP2
TP3
TP4
TPA
TPB
TPC
TPD

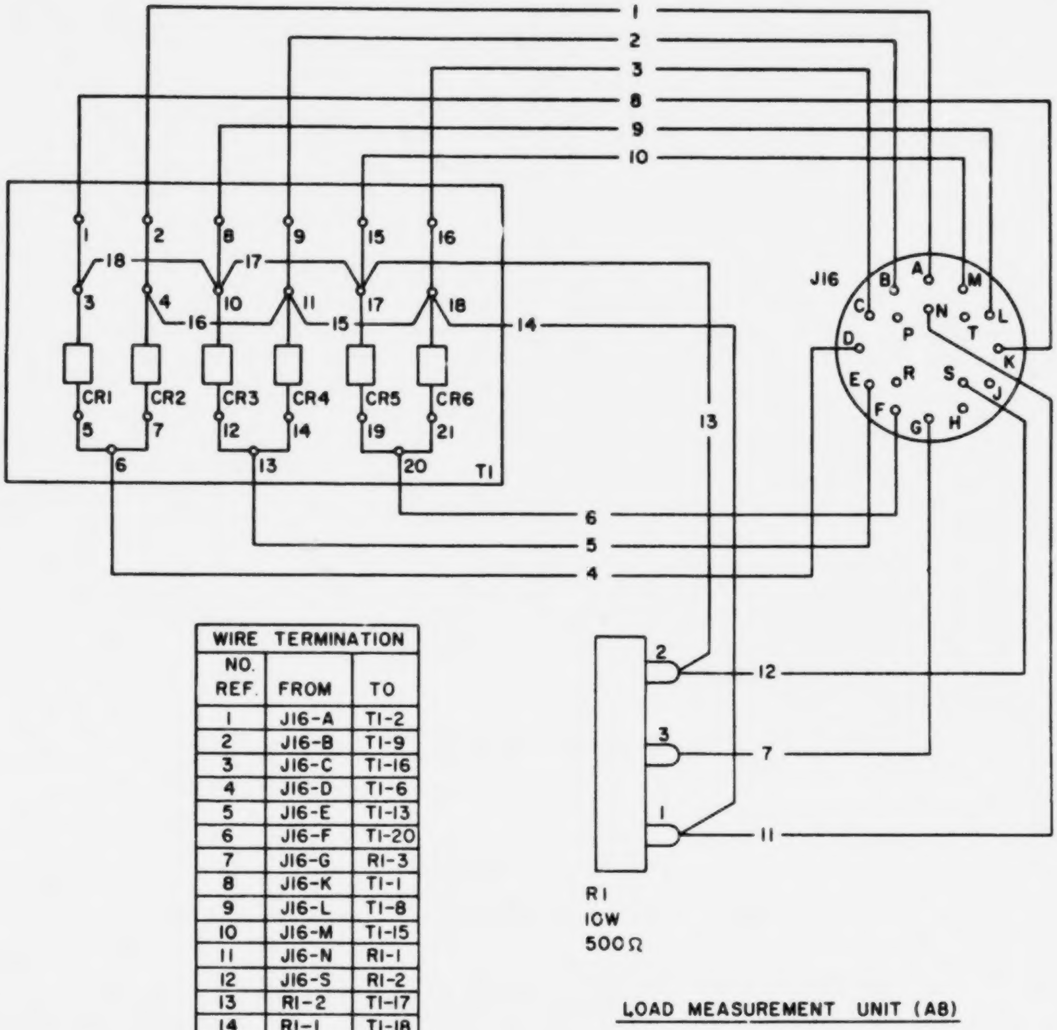
| REF DES | DESCRIPTION | REF DES | DESCRIPTION |
|---|---|---|---|
| A1 | GOVERNOR CONTROL UNIT SUBASSEMBLY | R14 | RESISTOR, VARIABLE, 3K OHMS, 4 WATT |
| J3 | CONNECTOR, RECEPTACLE | R15 | RESISTOR, VARIABLE, 500 OHMS, 2 WATT |
| P1 | CONNECTOR, RECEPTACLE | R16 | RESISTOR, VARIABLE, 25K OHMS, 2 WATT |
| P2 | CONNECTOR, RECEPTACLE | R18 | RESISTOR, VARIABLE, 10K OHMS, 2 WATT |
| P5 | CONNECTOR, RECEPTACLE | TPA THRU TPD | TEST POINTS |
| R11 | RESISTOR, VARIABLE, 5K OHMS, 4 WATT | TP1 THRU TP4 | TEST POINTS |
| R12 | RESISTOR, VARIABLE, 10K OHMS, 4 WATT | | |

Figure 1-17. 50/60 Hertz precise governor control unit (A23) wiring diagram


D
C
E
B
A
J25
YELLOW
BLUE
YELLOW
BLUE
L1
L2
CORE AND ARMATURE ASSEMBLY
SECONDARY WINDING
PRIMARY WINDING
RED
BLACK
WHITE
YELLOW
A
B
C
D
J24
GOVERNOR ACTUATOR (A24)

| REF DES | DESCRIPTION |
|---|---|
| A24 | ACTUATOR, PRECISE GOVERNOR |
| J24 | CONNECTOR, RECEPTACLE |
| J25 | CONNECTOR, RECEPTACLE |
| L1 | SOLENOID, ENGINE, FUEL |
| L2 | SOLENOID, DAY TANK, FUEL |

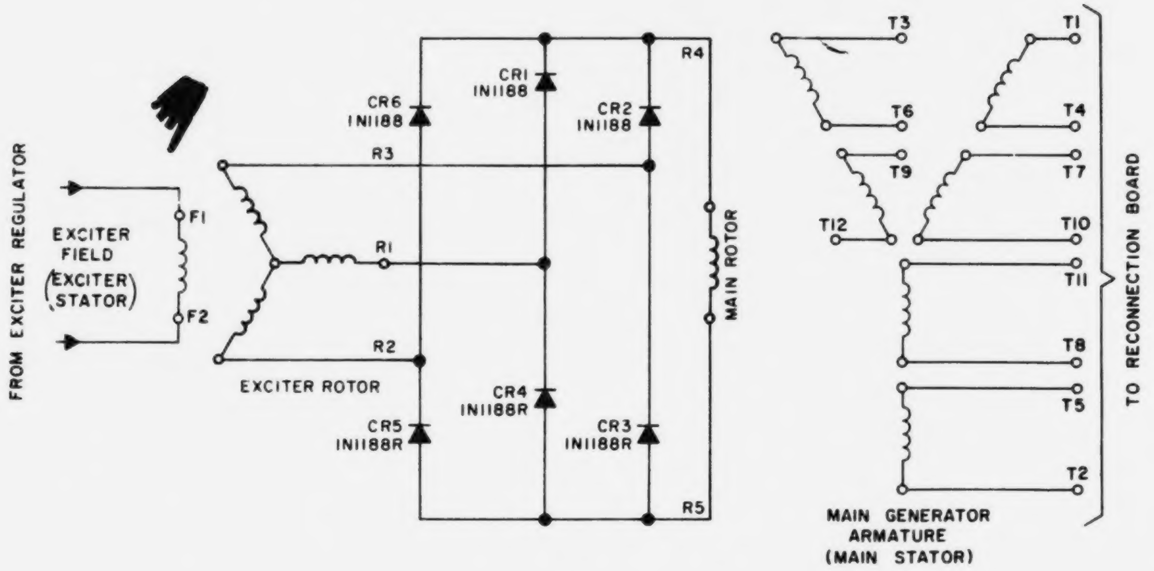
Figure 1-18. Precise governor actuator (A24) wiring diagram


1
2
3
8
9
10
1
2
8
9
15
16
18
17
3
4
10
11
17
18
16
15
14
CR1
CR2
CR3
CR4
CR5
CR6
5
7
12
14
19
21
6
13
20
T1
13
J16
A
B
M
C
N
L
T
P
D
K
E
R
S
J
F
G
H
6
5
4
2
12
3
7
1
11
R1
10W
500Ω
LOAD MEASUREMENT UNIT (A8)

| WIRE TERMINATION | | |
|---|---|---|
| NO. REF. | FROM | TO |
| 1 | J16-A | T1-2 |
| 2 | J16-B | T1-9 |
| 3 | J16-C | T1-16 |
| 4 | J16-D | T1-6 |
| 5 | J16-E | T1-13 |
| 6 | J16-F | T1-20 |
| 7 | J16-G | R1-3 |
| 8 | J16-K | T1-1 |
| 9 | J16-L | T1-8 |
| 10 | J16-M | T1-15 |
| 11 | J16-N | R1-1 |
| 12 | J16-S | R1-2 |
| 13 | R1-2 | T1-17 |
| 14 | R1-1 | T1-18 |
| 15 | T1-11 | T1-18 |
| 16 | T1-4 | T1-11 |
| 17 | T1-10 | T1-17 |
| 18 | T1-3 | T1-10 |

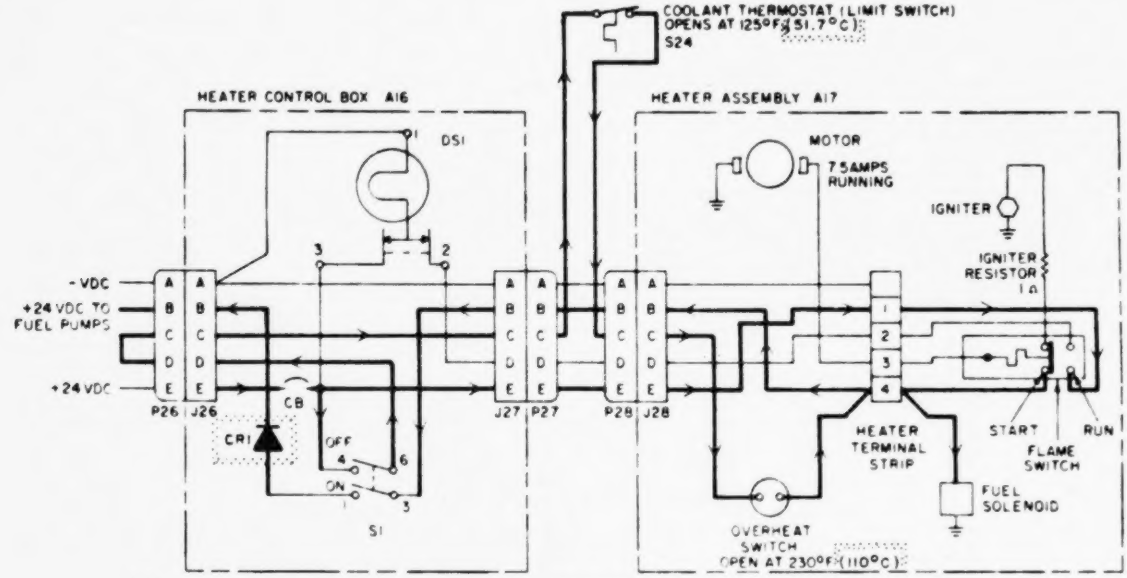
| REF DES | DESCRIPTION |
|---|---|
| J16 | CONNECTOR, RECEPTACLE |
| R1 | RESISTOR, ADJUSTABLE |
| T1 | TRANSFORMER ASSEMBLY |

Figure 1-19. Load measuring unit (A8) wiring diagram


FROM EXCITER REGULATOR
EXCITER FIELD (EXCITER STATOR)
F1
F2
R3
R1
R2
EXCITER ROTOR
CR6 1N1188
CR1 1N1188
CR2 1N1188
CR5 1N1188R
CR4 1N1188R
CR3 1N1188R
R4
R5
MAIN ROTOR
T3
T6
T9
T12
T1
T4
T7
T10
T11
T8
T5
T2
MAIN GENERATOR ARMATURE (MAIN STATOR)
TO RECONNECTION BOARD

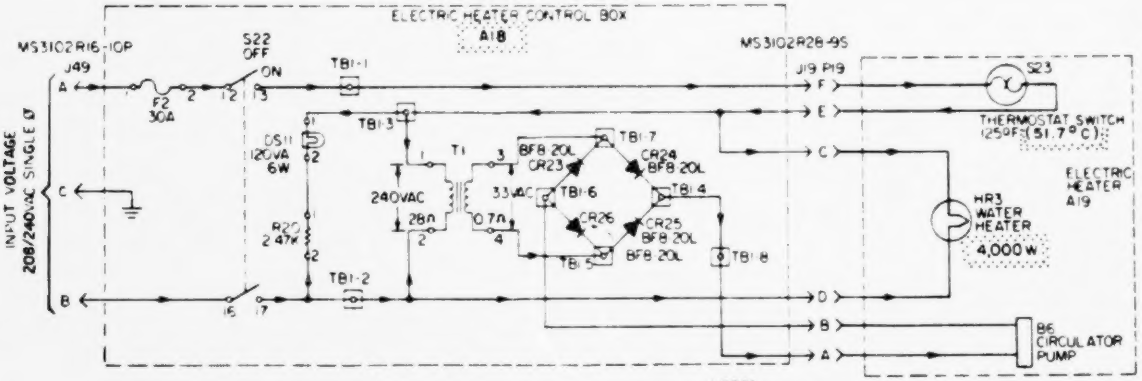
| REF DES | DESCRIPTION |
|---|---|
| CR1 THRU CR6 | DIODE |
| F1 THRU F2 | TERMINAL, EXCITER . (STATOR) FIELD COIL |
| R1 THRU R5 | TERMINAL, EXCITER (ROTOR) ARMATURE COIL |
| T1 THRU T12 | TERMINAL, MAIN (STATOR) GENERATOR ARMATURE COIL |

Figure 1-20. Generator assembly simplified schematic diagram


COOLANT THERMOSTAT (LIMIT SWITCH)
OPENS AT 125°F (51.7°C)
S24
HEATER CONTROL BOX A16
HEATER ASSEMBLY A17
DS1
MOTOR
7.5AMPS RUNNING
IGNITER
IGNITER RESISTOR 1 Ω
-VDC
+24 VDC TO FUEL PUMPS
+24 VDC
A
B
C
D
E
P26
J26
J27
P27
P28
J28
CB
CR1
OFF
ON
S1
1
2
3
4
6
HEATER TERMINAL STRIP
START
RUN
FLAME SWITCH
FUEL SOLENOID
OVERHEAT SWITCH
OPEN AT 230°F (110°C)

| | | | |
|---|---|---|---|
| A16 | CONTROL BOX, HEATER | J26 THRU J28 | CONNECTOR, RECEPTACLE |
| A17 | HEATER ASSEMBLY | P26 THRU P28 | CONNECTOR, PLUG |
| CB | CIRCUIT BREAKER | S1 | SWITCH, TOGGLE |
| CR1 | DIODE | S24 | SWITCH, THERMAL |
| DS1 | INDICATOR, LAMP | | |

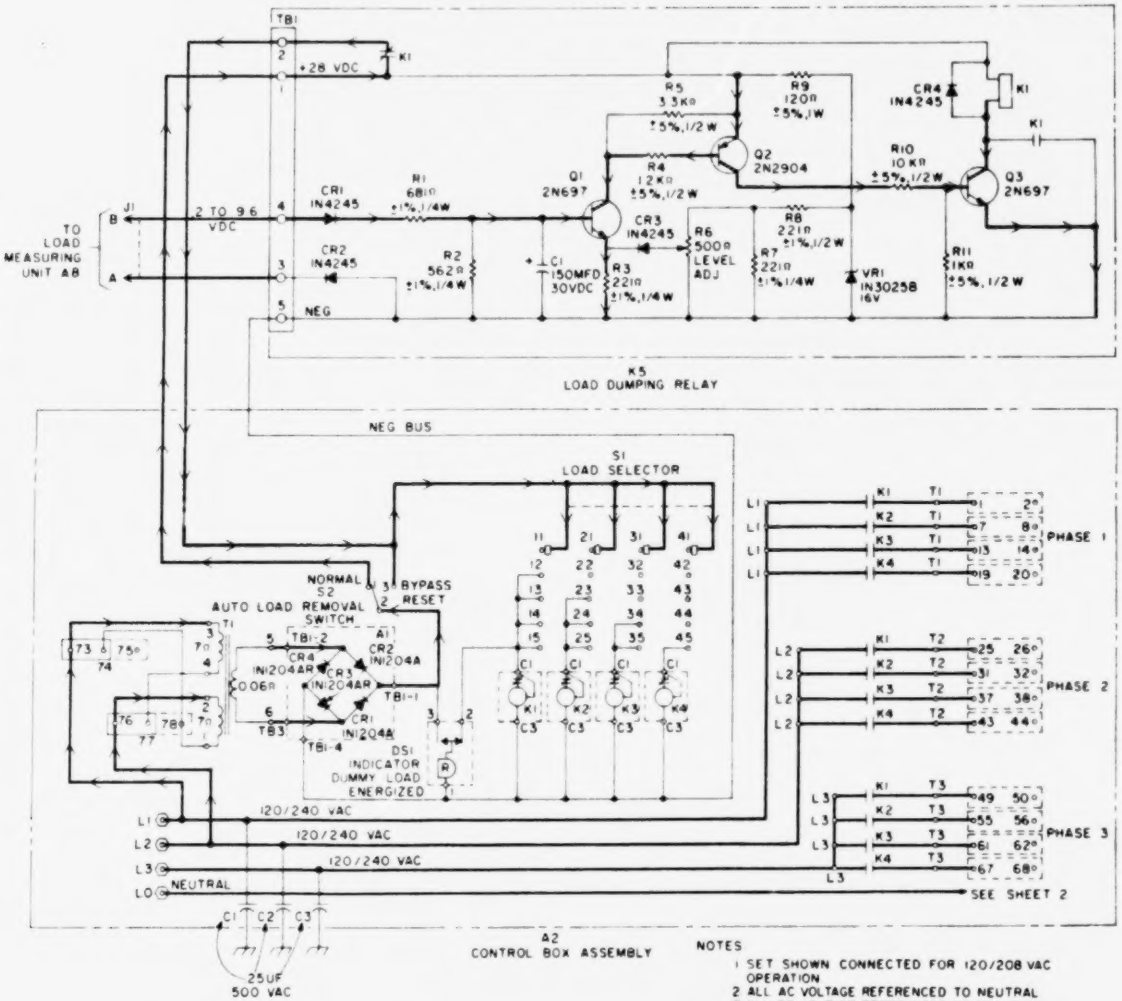
Figure 1-21. Fuel burning winterization kit (A17) schematic


ELECTRIC HEATER CONTROL BOX
A18
MS3102R16-10P
J49
S22
OFF
ON
F2
30A
TB1-1
TB1-2
TB1-3
DS11
120VA
6W
R20
2.47K
T1
240VAC
28Ω
33VAC
0.7Ω
BF8 20L
CR23
CR24
CR25
CR26
TB1-4
TB1-5
TB1-6
TB1-7
TB1-8
INPUT VOLTAGE 208/240VAC SINGLE Ø
A
B
C
D
E
F
MS3102R28-9S
J19 P19
S23
THERMOSTAT SWITCH
125°F (51.7°C)
ELECTRIC HEATER A19
HR3
WATER HEATER
4,000 W
B6
CIRCULATOR PUMP

NOTES
1 ALL AC VOLTAGE MEASUREMENTS ARE MADE WITH A 5,000 OHM PER VOLT METER

| | | | |
|---|---|---|---|
| B6 | PUMP, CIRCULATING | | |
| CRI | DIODE, BLOCKING | P19 | CONNECTOR, PLUG |
| CR23 THRU CR26 | DIODE, FULL WAVE BRIDGE | R20 | RESISTOR, FIXED |
| DS11 | INDICATOR LAMP | S22 | SWITCH, TOGGLE |
| F2 | FUSE | S23 | SWITCH, THERMAL |
| HR3 | HEATER | T1 | TRANSFORMER |
| J19 | CONNECTOR, RECEPTACLE | TB1 | TERMINAL BOARD |
| J49 | CONNECTOR, RECEPTACLE | | |

Figure 1-22. Electric winterization kit (A18) schematic


TB1
+28 VDC
K1
J1
B
A
TO LOAD MEASURING UNIT A8
2 TO 9.6 VDC
CR1 1N4245
CR2 1N4245
NEG
R1 681Ω ±1%,1/4W
R2 562Ω ±1%,1/4W
C1 150MFD 30VDC
Q1 2N697
R3 221Ω ±1%,1/4W
CR3 1N4245
R6 500Ω LEVEL ADJ
R7 221Ω ±1%,1/4W
R8 221Ω ±1%,1/2W
VR1 1N3025B 16V
R4 12KΩ ±5%,1/2W
R5 3.3KΩ ±5%,1/2W
Q2 2N2904
R9 120Ω ±5%,1W
R10 10KΩ ±5%,1/2W
Q3 2N697
R11 1KΩ ±5%,1/2W
CR4 1N4245
K5
LOAD DUMPING RELAY
NEG BUS
S1
LOAD SELECTOR
NORMAL
S2
AUTO LOAD REMOVAL SWITCH
BYPASS
RESET
T1
73 74 75
76 77 78
.006Ω
TB1-2
CR4 1N1204AR
CR3 1N1204AR
A1
CR2 1N1204A
CR1 1N1204A
TB1-1
TB1-4
TB3
DS1 INDICATOR DUMMY LOAD ENERGIZED
R
C1 K1 C3
C1 K2 C3
C1 K3 C3
C1 K4 C3
L1 L2 L3 LO
120/240 VAC
NEUTRAL
T1 T2 T3
PHASE 1
PHASE 2
PHASE 3
SEE SHEET 2
C1 C2 C3
25UF 500 VAC
A2
CONTROL BOX ASSEMBLY

NOTES
1 SET SHOWN CONNECTED FOR 120/208 VAC OPERATION
2 ALL AC VOLTAGE REFERENCED TO NEUTRAL
3 ALL DC VOLTAGE REFERENCED TO NEG BUS
4 ⏚ DENOTES CHASSIS GROUND

| REF DES | DESCRIPTION | REF DES | DESCRIPTION |
|---|---|---|---|
| A2 | CONTROL BOX ASSEMBLY | K5 CR4 | DIODE |
| A2A1 CR1, CR2 | DIODE | K5 K1 | RELAY |
| A2 C1 THRU C3 | CAPACITOR, FIXED | K5 Q1 | TRANSISTOR |
| A2 CR3, CR4 | DIODE | K5 Q2 | TRANSISTOR |
| A2 DS1 | INDICATOR LAMP | K5 Q3 | TRANSISTOR |
| A2 K1 AND K4 | RELAY | K5 R1 | RESISTOR, FIXED |
| A2 LO THRU L3 | TERMINALS, LOAD | K5 R2 | RESISTOR, FIXED |
| A2 S1 | SWITCH, LOAD SELECTOR | K5 R3 | RESISTOR, FIXED |
| A2 S2 | SWITCH, AUTO LOAD REMOVAL | K5 R4 | RESISTOR, FIXED |
| A2 T1 | TRANSFORMER | K5 R5 | RESISTOR, FIXED |
| A3 | CONTROL CUBICLE | K5 R6 | RESISTOR, ADJUSTABLE |
| A3 R1 THRU R48 | RESISTOR, FIXED | K5 R7 | RESISTOR, FIXED |
| J1 | CONNECTOR, RECEPTACLE | K5 R8 | RESISTOR, FIXED |
| K5 | RELAY, LOAD DUMPING | K5 R9 | RESISTOR, FIXED |
| K5 C1 | CAPACITOR, FIXED | K5 R10 | RESISTOR, FIXED |
| K5 CR1 | DIODE | K5 R11 | RESISTOR, FIXED |
| K5 CR2 | DIODE | K5 TB1 | TERMINAL BOARD |
| K5 CR3 | DIODE | K5 VR1 | DIODE, ZENER |

Figure 1-23. Dummy load kit (A28) schematic (sheet 1 of 2)

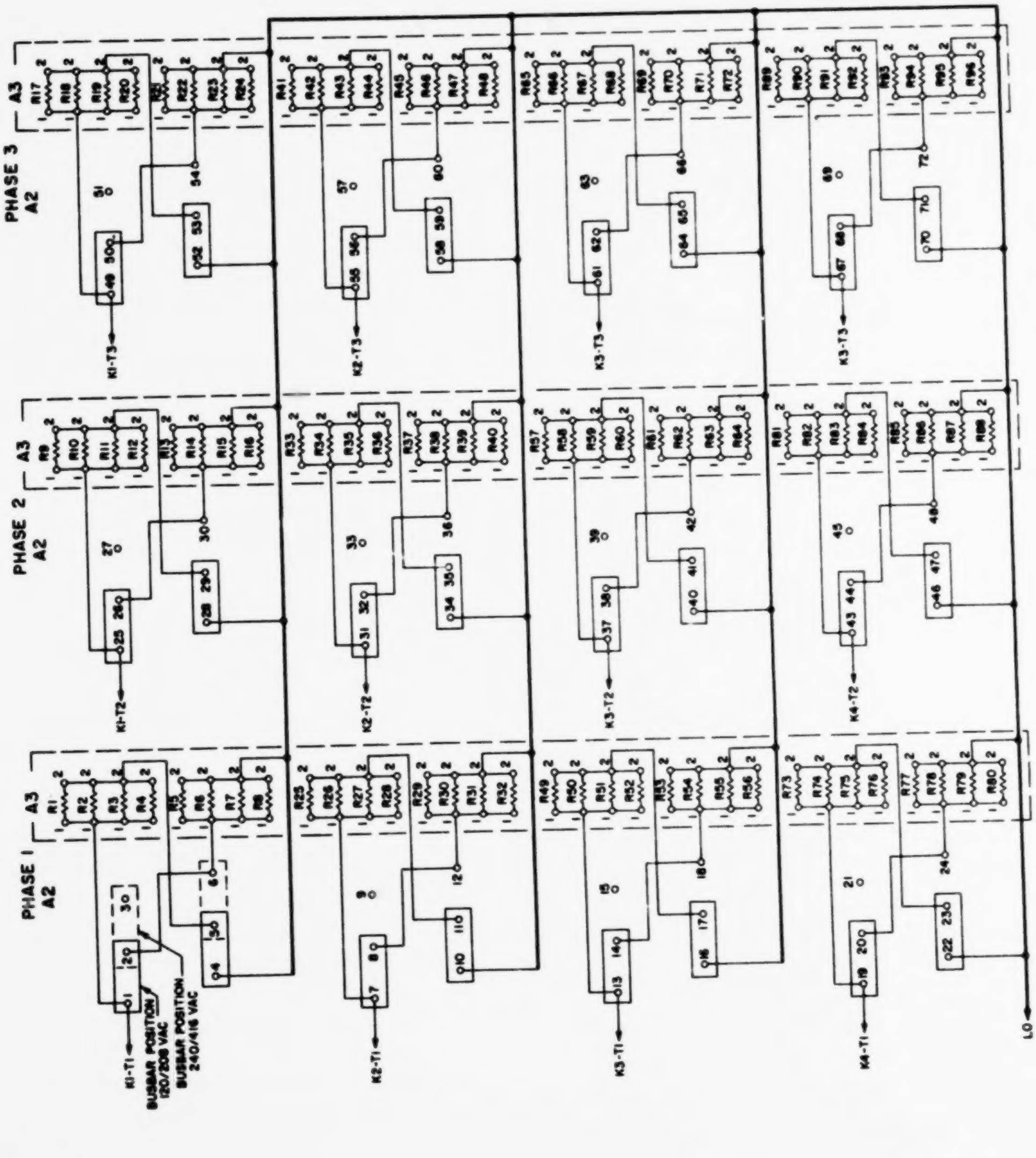

PHASE 1
A2
A3
PHASE 2
A2
A3
PHASE 3
A2
A3
K1-T1
BUSBAR POSITION 120/208 VAC
BUSBAR POSITION 240/416 VAC
K2-T1
K3-T1
K4-T1
K1-T2
K2-T2
K3-T2
K4-T2
K1-T3
K2-T3
K3-T3
K3-T3
LO

Figure 1-23. Dummy load kit (A28) schematic (sheet 2 of 2)

# CHAPTER 2

# GENERAL MAINTENANCE INSTRUCTIONS

## Section I. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

### 2-1. SPECIAL TOOLS AND EQUIPMENT.

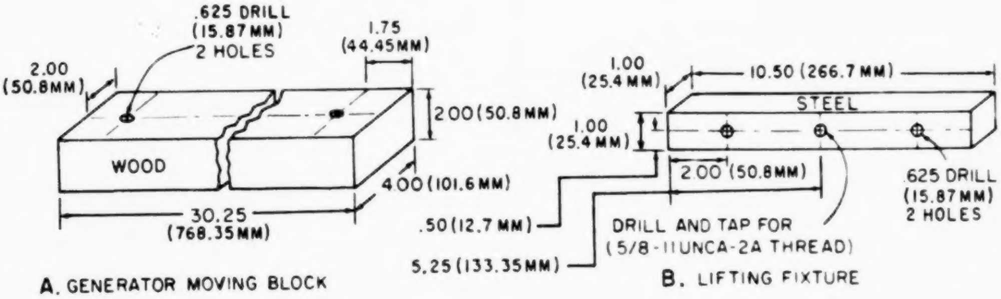
There are no special tools and equipment required to perform intermediate (field) (direct and general support) and depot maintenance on generator sets Models MEP009A and MEP108A.

### 2-2. ORGANIZATIONAL, INTERMEDIATE (FIELD) (DIRECT SUPPORT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE REPAIR PARTS.

Refer to Organizational, Intermediate (Field) (Direct Support and General Support) and Depot Maintenance Repair Parts and Special Tools List.

### 2-3. FABRICATED TOOLS AND EQUIPMENT.

The fabricated tools and equipment illustrated in figure 2-1 and listed in table 2-2 are for immediate (field) (direct and general support) and depot maintenance personnel performing maintenance on the generator set. The tools and equipment listed in table 2-2 are not available for issue, but must be fabricated by qualified maintenance personnel.


.625 DRILL
(15.87MM)
2 HOLES
1.75
(44.45MM)
2.00
(50.8MM)
2.00 (50.8MM)
WOOD
4.00 (101.6MM)
30.25
(768.35MM)
1.00
(25.4MM)
10.50 (266.7MM)
STEEL
1.00
(25.4MM)
2.00 (50.8MM)
.625 DRILL
(15.87MM)
2 HOLES
.50 (12.7MM)
DRILL AND TAP FOR
(5/8-11UNCA-2A THREAD)
5.25 (133.35MM)

A. GENERATOR MOVING BLOCK

B. LIFTING FIXTURE

NOTE: All dimensions are in inches unless otherwise noted.

Figure 2-1. Specially designed tools (fabricated)

Table 2-1. Recommended Tools and Equipment

| ITEM | FSN OR PART NUMBER | REFERENCE PARA | REFERENCE FIG. | USE |
|---|---|---|---|---|
| Ohmmeter | 6625-581-2466 (or equivalent) | 6-19 | | Check continuity and resistance of electrical components. |
| Inside micrometer | | 8-232 | | To measure inside diameter of engine components. |
| Outside micrometer | | 8-129 | | To measure outside diameter of engine components. |
| Wheatstone bridge | | 6-19 | | To measure resistance of electrical components. |
| Kelvin bridge | | 6-19 | | To measure resistance of electrical components. |
| Multimeter | | 6-19 | | To test electrical components. |
| Pressure gauge 0-20 PSI | | 4-10 | | To check radiator pressure. |
| Radiator cap tester | | 4-13 | | To check radiator cap. |
| Vacuum tube DC voltmeter 0-50 MV | | 6-3 | 6-1 | To test thermal watt converter. |
| Power source 120/208 ± 2 VAC 3 phase, 4 wire, 60 hertz | | 6-3 | 6-1 | To test thermal watt converter. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE PARA | FIG. | USE |
|---|---|---|---|---|
| Ammeter 0-1.5 AMPERES | | 6-3 | 6-1 | To test thermal watt converter. |
| Auto transformer 75 VOLT-AMPERES | | 6-3 | 6-1 | To test thermal watt converter. |
| Variable frequency supply, 120V 45-75 Hz | | 6-9 | 6-2 | To test frequency meter and frequency transducer. |
| Test frequency meter | | 6-9 | 6-2 | To test frequency meter and frequency transducer. |
| Power source 120 ± 2 VAC 50 or 60 Hz | | 6-16 | 6-3 | To test control box relay assembly. |
| Voltmeter 120 ± 2 VAC | | 6-16 | 6-3 | To test control box relay assembly. |
| Power supply 24 ± 2 VDC 0.5 AMP | | 6-19 | 6-5 | To test relay. |
| Power supply 120 ± 2 VAC, 60 Hz | | 6-27 | 6-6 | To test AC current meter. |
| Auto transformer 75 VA, 60 Hz (Quantity of 3) | | 6-27 | 6-6 | To test AC current meter. |
| Ammeter 0-1.5 AMPERES (Quantity of 3) | | 6-27 | 6-6 | To test AC current meter. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP | | 6-50 | 6-10 | To test indicator box. |
| Power source<br>24 ± 2 VDC<br>3 AMP | | 6-68 | 6-15 | To test exciter-regulator. |
| Power source<br>0-130 ± 2 VAC<br>60 Hz | | 6-68 | 6-15 | To test exciter-regulator. |
| Ammeter<br>0-3 AMPS DC | | 6-68 | 6-15 | To test exciter-regulator. |
| Ammeter<br>0-10 AMPS DC | | 6-68 | 6-15 | To test exciter-regulator. |
| Voltmeter<br>0-130 VAC<br>10 AMP | | 6-68 | 6-15 | To test exciter-regulator. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP | | 6-80 | 6-22 | To test DC relay assembly. |
| Power supply<br>0-60 Hz<br>120 ± 2 VAC | | 6-80 | 6-22 | To test DC relay assembly. |
| Power supply<br>24 ± 2 VDC<br>3 AMP | | 6-89 | 6-24 | To test Mode I relay box assembly. |
| Power supply<br>120 ± 2 VAC<br>60 ± 0.5 HZ<br>5 AMP | | 6-89 | 6-24 | To test Mode I relay box assembly. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Voltmeter 0-15 VAC SCALE | | 6-89 | 6-24 | To test Mode I relay box assembly. |
| Ohmmeter R x 1000 SCALE | | 6-89 | 6-24 | To test Mode I relay box assembly. |
| Ammeter 0-3 AMP SCALE | | 6-89 | 6-24 | To test Mode I relay box assembly. |
| Power supply<br>24 ± 4 VDC<br>5 AMPS | | 6-106 | 6-29 | To test circuit breaker assembly. |
| Variable voltage power supply<br>0-75 VAC 3<br>3 AMPS | | 6-124 | 6-34 | To test current transformers. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP | | 6-131 | 6-36 | To test over voltage relay. |
| Variable voltage power supply<br>0-160 ± 4 VAC<br>60 HERTZ | | 6-131 | 6-36 | To test over voltage relay. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE |  | USE |
|---|---|---|---|---|
|  |  | PARA | FIG. |  |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP |  | 6-140 | 6-39 | To test reverse power relay. |
| Oscillator |  | 6-140 | 6-39 | To test reverse power relay. |
| Variable voltage power supply<br>0-10 ± 1 VDC<br>1 AMP |  | 6-140 | 6-39 | To test reverse power relay. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP |  | 6-149 | 6-42 | To test short circuit relay. |
| Power source<br>0-50 ± 5 VAC<br>60 hertz single phase 4 AMP |  | 6-149 | 6-42 | To test short circuit relay. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP |  | 6-158 | 6-45 | To test overload relay. |
| Power source<br>120/208 ± 2 VAC<br>30, 4 wire<br>60 Hertz 3 AMP |  | 6-158 | 6-45 | To test overload relay. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Resistor<br>35 OHM ± 1%<br>50 WATT<br>(Quantity of 3) | | 6-158 | 6-45 | To test overload relay. |
| Transformer<br>2 AMP<br>(Quantity of 3) | | 6-158 | 6-45 | To test overload relay. |
| Ammeter<br>0-3 AMPS<br>(Quantity of 3) | | 6-158 | 6-45 | To test overload relay. |
| Power supply<br>24 ± 2 VDC<br>2 AMP | | 6-162 | 6-46 | To test tactical relay box. |
| Power supply<br>0-10 ± 1 VDC<br>0.5 AMP | | 6-162 | 6-46 | To test tactical relay box |
| Power supply<br>0-160 ± 4 VAC<br>50/60 Hz<br>1 AMP | | 6-162 | 6-46 | To test tactical relay box. |
| Power supply<br>0-50 VOLT<br>3/phase<br>50/60 HZ 4 wire<br>5 AMP | | 6-162 | 6-46 | To test tactical box. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Ammeter<br>0 to 2 AMP AC | | 6-162 | 6-46 | To test tactical relay box. |
| Voltmeter<br>0-12 VDC | | 6-162 | 6-46 | To test tactical relay box. |
| Voltmeter<br>0-180 VAC | | 6-162 | 6-46 | To test tactical relay box. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP | | 6-172 | 6-50 | To test under frequency relay. |
| Variable frequency power supply<br>0-65 hertz<br>120 ± 2 VAC | | 6-172 | 6-50 | To test under frequency relay. |
| Frequency meter<br>0-100 HZ | | 6-172 | 6-50 | To test underfrequency relay. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP | | 6-181 | 6-53 | To test under voltage relay. |
| Variable voltage power supply<br>0-130 ± 5 VAC,<br>60 HZ 1 AMP | | 6-181 | 6-53 | To test under voltage frequency. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP | | 6-190 | 6-56 | To test permissive paralleling relay. |
| Variable voltage power supply<br>0-20 ± 1 VAC<br>50 or 60 hertz<br>1 AMP | | 6-190 | 6-56 | To test permissive paralleling relay. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Power supply 120/208 ± 2 VAC 30, 4 wire 47-75 HZ 10 AMP | | 6-228 | 6-70 | To test load measuring unit. |
| Ammeter 1 AMP (Quantity of 3) | | 6-228 | 6-70 | To test load measuring unit. |
| Voltmeter 0-5.6 ± 0.5 VAC | | 6-228 | 6-70 | To test load measuring unit. |
| Voltmeter 0-10 VDC | | 6-228 | 6-70 | To test load measuring unit. |
| Power supply 0-10 ± 2 VDC 15 AMP | | 7-2<br>7-5 | | To check generator component. |
| Megger 500 VOLT | | 7-2 | | To check generator component. |
| Variable speed drive (2000 to 3000 RPM) | | 8-19 | | To check alternator speed. |
| Resistor (1/2 OHM 500 WATT) | | 8-19 | | Used in alternator voltage regulator setting test. |
| DC voltmeter 0 to 50 volt scale | | 8-19<br>8-28 | | Used in alternator and starter motor test. |
| Carbon pile (0 to 600 ampere load capacity) | | 8-19<br>8-28 | | Used in alternator and starter motor test. |
| Ammeter 0 to 50 ampere scale | | 8-19<br>8-28 | | Used in alternator and starter motor test. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE PARA | REFERENCE FIG. | USE |
|---|---|---|---|---|
| Armature test set | 6625-238-1459 (or equivalent) | 8-25 | | To test starter motor armature for ground. |
| Spring scale (0 to 100 pound scale) | | 8-25 | | To check starter motor brush spring for proper tension. |
| Growler | | 8-25 | | To check starter motor armature for shorts. |
| Mica undercutter | 4940-204-0319 (or equivalent) | 8-26 | | To undercut mica and starter motor commutator. |
| Spring scale (0 to 50 pound scale) | | 8-28 | | Used in starter motor stall torque test. |
| Torque arm (12 inch long) | | 8-28 | | Used in starter motor stall torque test. |
| Hand held tachometer (0 to 10,000 RPM) | | 8-28 | | Used in starter motor stall torque test. |
| Variable speed drive (0 to 3000 RPM) | | 8-51 | | Used to check trip settings on overspeed switch. |
| Hydraulic test stand | | 8-98 | | To test hydraulic pump. |
| Variable speed drive (0 to 2500 RPM) | | 8-98 | | To test hydraulic pump. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Pressure gauge 0 to 400 PSI (0 to 28.12 kg/sq cm) | | 8-98 | | To test hydraulic pump. |
| Universal puller kit | 3180-701-8046 (or equivalent | 8-99<br>8-143<br>8-222 | | To remove timing gears and crankshaft pulley. |
| Rack setting tool | | 8-132 | | Used to adjust governor drive housing. |
| Dial indicator 0 to 1 inch (0 to 25.4 mm) | | 8-132 | | Used to adjust governor drive housing. |
| Diesel injector tool test set | 4910-317-8265 (or equivalent) | 8-141 | | To test fuel injection pump. |
| Diesel injector pump test stand | 4910-443-0976 (or equivalent) | 8-141 | | To test fuel injection pump. |
| Kit, Rack adjust or substitute the individual components of kit 1P5600 listed below: | 1P5600 | 8-141 | 8-37 | Adjust rack |
| Washer | 2S6160 | | | |
| Bolt | S509 | | | |
| Bolt | S1617 | | | |
| Wrench | 9M4567 | | | |
| Wrench | 9M4568 | | | |
| Plate | 1P7410 | | | |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Pointer | 9H3970 | 8-141 | 8-37 | Injector Timing |
| Shaft | 9H3973 | 8-141 | 8-37 | |
| Gage | 6F6922 | 8-141 | 8-37 | Adjust timing dimension |
| Kit, pump alignment | 9S240 | 8-139 | 8-34 | Check alignment of pump to engine |
| Extractor | 85-2244 | 8-136 | 8-34 | Fuel pump bushing removal |
| Wrench | 85-2243 | 8-136 | 8-34 | Fuel pump bushing removal |
| Wrench | 85-4613 | 8-136 | 8-34 | Fuel pump bushing |
| Block | 2M5219 | 8-141 | 8-37 | Adjust timing dimension |
| Block | 85715 | 8-141 | 8-37 | Adjust timing dimension |
| Precombustion chamber | 5120-157-0718 (or equivalent) | 8-182 | | To remove precombustion chamber from cylinder head. |
| Valve face grinding machine | 4910-540-4679 (or equivalent) | 8-185 | | To reface rocker arm contact surface and intake and exhaust valves. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE PARA | REFERENCE FIG. | USE |
|---|---|---|---|---|
| Thickness gauge | 5210-221-1999 (or equivalent) | 8-187 | | To adjust valve lash. |
| Valve spring test stand | | 8-184 | | To test intake and exhaust valve springs. |
| Valve seat grinding kit | 4910-473-6437 (or equivalent) | 8-185 | | To reface intake and exhaust valve seats. |
| Depth micrometer (0 to 1 inch) (0 to 25.4 mm) | | 8-234 | | Used to measure cylinder liner height projection. |
| Spring tester | | 11-13 | | To check heater spring. |
| Power supply 24 ± 2 VDC 12 AMP | | 11-13 | | To check heater component. |
| Dial indicator | | 11-13 | | To check heater component. |
| Ammeter 0-10 AMP | | 11-16 | 11-4 | To test coolant pump. |
| Voltmeter 0-30 VOLT | | 11-16 | 11-4 | To test coolant pump. |
| Pressure gauge 0-50 PSI (0-3.515 Kg/sq cm) | | 11-16 | 11-4 | To test coolant pump. |
| Power supply 24 ± 2 VDC 0.5 AMP | | 11-16 | 11-4 | To test coolant pump. |
| Strobe light | | 11-16 | | To check coolant pump. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Power supply<br>120 ± 2 VAC<br>50 or 60 hertz | | 13-5 | | To test heater element. |
| Ammeter<br>0-10 AMP AC | | 13-5 | | To test heater element. |
| Power supply<br>24 ± 2 VDC<br>0.5 AMP | | 13-13 | 13-5 | To test load dumping relay. |
| Voltmeter<br>0-10 VDC | | 13-13 | 13-5 | To test load dumping relay. |
| Power supply<br>0-10 VDC<br>0.5 AMP | | 13-13 | 13-5 | To test load dumping relay. |
| Power supply<br>24 ± 4 VDC<br>0.5 AMP | | 13-25 | | To test contactors. |
| Ammeter<br>0-5 AMP AC | | 13-25 | | To test contactors. |
| Megger<br>500 VOLT | | 13-25 | | To test transformer windings. |
| Power supply<br>120 VAC<br>50 or 60 hertz | | 13-25 | | To test transformer. |

Table 2-1. Recommended Tools and Equipment (Continued)

| ITEM | FSN OR PART NUMBER | REFERENCE | | USE |
|---|---|---|---|---|
| | | PARA | FIG. | |
| Ammeter 0-3 AMP AC | | 13-25 | | To test transformer. |
| Voltmeter 0-50 VAC | | 13-25 | | To test transformer. |
| Multimeter | | 13-25 | | To test diodes. |

Table 2-2. Specially Designed (Fabricated) Tools and Equipment

| ITEM | REFERENCE | | USE |
|---|---|---|---|
| | FIGURE | PARAGRAPH | |
| Generator moving block | 2-1A | 7-3 | Used when moving generator. |
| Lifting fixture | 2-1B | 7-3 | Used during disassembly of generator. |

## Section II. TROUBLESHOOTING

### 2-4. GENERAL.

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the engine generator sets and their components. Malfunctions which may occur are listed in table 2-3. Each malfunction stated is followed by a list of probable causes of the trouble. The corrective action recommended is described opposite the probable cause.

Table 2-3. Troubleshooting

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| | GENERATOR SET | |
| 1. Start-stop run switch positioned to START but engine does not turn over. | a. Defective dc voltage assembly, mode I relay box. | a. Test relay (paragraph 6-88). Test relay box (paragraph 6-88). |
| | b. Defective or improperly adjusted overspeed switch (S9-1). | b. Repair or adjust switch (paragraph 8-46 or 8-51). |
| | c. Defective starter. | c. Repair STARTER (paragraph 8-23). |
| | d. Defective flywheel ring gear. | d. Replace gear (paragraph 8-195). |
| 2. Start-stop-run switch positioned to START; engine turns over but does not start. | a. Defective governor linkage. | a. Repair linkage (paragraph 8-130). |
| | b. Defective or improperly adjusted utility governor. | b. Adjust or repair governor (paragraph 8-127 or 8-132). |
| | c. Defective fuel pump. | c. Repair pump (paragraph 8-63). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 2. Start-stop-run switch positioned to START; engine turns over but does not start. (continued) | d. Defective governor actuator. | d. Test and repair if defective (paragraphs 8-110 through 8-115). |
| | e. Defective or improperly adjusted over speed switch (S9-1). | e. Repair or adjust switch (paragraphs 8-46 through 8-51). |
| | f. Engine not properly timed. | f. Reset accessory drive shaft timing (paragraph 8-148). |
| 3. Engine shuts down after positioning start-stop-run switch to RUN. | a. Defective control box relay assembly. | a. Test and repair if defective (paragraph 6-15). |
| | b. Defective over voltage relay K2. | b. Test relay (paragraph 6-130). |
| | c. Defective mode I relay box. | c. Test relay box (paragraph 6-78. |
| 4. Precise governor fails to take over after starting. Engine speed increases and remains at 2250 rpm (precise generator sets). | a. Defective or improperly adjusted speed switch (S9-2). | a. Repair or adjust switch (paragraph 8-46 or 8-51). |
| | b. 120 vac not supplied to control unit receptacle P1 pins A and B. | b. Repair or replace wiring. |
| | c. Defective governor linkage. | c. Repair linkage (paragraph 8-127 or 8-132). |
| | d. Defective governor actuator | d. Test and repair if defective (paragraph 8-110 or 8-115). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 4. Precise governor fails to take over after starting. Engine speed increases and remains at 2250 rpm (precise generator sets). (continued) | e. Defective governor control unit. | e. Test and repair if defective (paragraph 6-216). |
| | f. Defective hydraulic pump. | f. Test and replace if defective (paragraph 8-94 or 8-98). |
| 5. During operation, engine fuel throttle goes to minimum fuel position (precise generator sets). | a. Defective governor actuator. | a. Test and repair if defective (paragraph 8-110 or 8-115). |
| | b. Defective governor control unit. | b. Test and repair if defective (paragraph 6-216). |
| 6. Generator voltage fails to build up. | a. Defective dc relay assembly, A5 field flash relay K5, in mode I relay box. | a. Test relay (paragraph 6-79. |
| | b. Defective or improperly adjusted speed switch (S9-1). | b. Repair or adjust switch (paragraph 8-46 or 8-51). |
| | c. Defective exciter-regulator A10 and A11. | c. Test exciter-regulator (paragraph 6-67). |
| | d. Defective (shorted) current transformer CT4, CT5, or CT6. | d. Test and replace if defective (paragraph 6-124). |
| | e. Defective generator. | e. Test and repair if defective (paragraph 7-2). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 7. Generator voltage does not respond to adjustment of voltage adjusting rheostat R2. | a. Defective control box relay assembly A4. | a. Test and repair if defective (paragraph 6-15). |
| | b. Defective exciter-regulator A10 and A11. | b. Test and repair if defective (paragraph 6-67). |
| 8. Generator output voltage erratic; frequency is stable. | a. Defective exciter-regulator A10 and A11. | a. Test and replace if defective (paragraph 6-67). |
| | b. Defective current transformers CT4, CT5, or CT6. | b. Test and replace if defective (paragraph 6-124). |
| | c. Defective generator. | c. Test and repair if defective (paragraph 7-2). |
| 9. Generator frequency fails to attain rated value after start-up (precise generator sets). | a. Precise governor system not properly aligned. | a. Align system (paragraph 6-225). |
| | b. Defective precise box. | b. Test relay box (paragraph 6-171). |
| | c. Defective or improperly adjusted hydraulic pump. | c. Test and replace if defective (paragraph 8-98). |
| | d. Defective governor actuator. | d. Test (paragraph 8-115). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 9. Generator frequency fails to attain rated value after start-up (precise generator sets). (continued) | e. Defective precise governor control unit. | e. Test and repair if defective (paragraph 6-216). |
| | f. Improperly adjusted engine fuel rack. | f. Adjust fuel rack (paragraph 8-117). |
| 10. Generator frequency fails to attain rated value (utility generator sets). | a. Defective or improperly adjusted utility governor. | a. Adjust or repair if defective (paragraph 8-127). |
| | b. Improperly adjusted fuel rack. | b. Adjust fuel rack (paragraph 8-140). |
| | c. Defective governor linkage | c. Repair linkage (paragraph 8-127). |
| 11. Generator frequency erratic (NO LOAD). | a. Defective current transformers CT1, CT2, or CT3. | a. Test and replace if defective (paragraph 6-124). |
| | b. Defective or improperly adjusted utility governor. | b. Adjust or repair if defective (paragraph 8-127). |
| | c. Precise governor system not properly aligned. | c. Align system (paragraph 6-225). |
| | d. Defective hydraulic pump (precise generator sets). | d. Test and replace if defective (paragraph 8-94 or 8-98). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 11. Generator frequency erratic (NO LOAD). (continued) | e. Defective precise generator actuator. | e. Test and repair if defective (paragraph 8-110 or 8-115). |
| | f. Defective precise governor control unit. | f. Test and repair if defective (paragraph 6-216). |
| | g. Defective precise box (precise generator sets). | g. Test relay box (paragraph 6-171). |
| | h. Defective exciter regulator | h. Test exciter regulator (paragraph 6-67). |
| 12. Frequency drifts under steady load (precise generator sets). | a. Defective governor control unit. | a. Test and repair if defective (paragraph 6-216). |
| | b. Defective precise governor actuator. | b. Test and repair if defective (paragraph 8-110 or 8-115). |
| | c. Defective hydraulic pump | c. Test and replace if defective (paragraph 8-94 or 8-98). |
| 13. Generator set frequency regulation is not isochronous (precise generator sets). | a. Defective precise relay box. | a. Test relay box (paragraph 6-171). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| | GENERATOR SET (Continued) | |
| | ENGINE SHUTS DOWN AND/OR LOAD CONTACTOR OPENS DUE TO PROTECTIVE FUNCTION AND FAULT LOCATOR INDICATOR ILLUMINATES AS FOLLOWS: | |
| 14. Low oil pressure indicator DS1. | a. Broken oil line or fitting. | a. Repair or replace. |
| | b. Defective oil pump. | b. Repair pump (paragraph 8-174). |
| | c. Clogged or defective oil cooler. | c. Clean, inspect and repair cooler (paragraph 8-77 thru 8-84). |
| 15. Overspeed indicator DS2. | a. Defective or improperly adjusted utility governor. | a. Test and repair if defective (paragraph 8-127 or 8-132). |
| | b. Defective governor linkage. | b. Repair linkage (paragraph 8-127). |
| | c. Improperly adjusted fuel rack. | c. Adjust rack (paragraph 8-140). |
| | d. Defective precise governor actuator (precise generator sets). | d. Test and repair if defective (paragraph 8-110 or 8-115). |
| | e. Defective governor control unit (precise generator sets). | e. Test and repair if defective (paragraph 6-216). |
| | f. Defective or improperly adjusted speed switch (S9-1). | f. Repair or adjust switch (paragraph 8-46 or 8-51). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 16. Short circuit indicator DS3. | a. Defective short circuit relay (K13). | a. Test relay (paragraph 6-148). |
| 17. Under voltage indicator DS4 (precise generator sets). | a. Defective current transformers CT4, CT5, or CT6. | a. Test and replace if defective (paragraph 6-124). |
| | b. Defective exciter regulator. | b. Test exciter regulator (paragraph 6-67). |
| | c. Defective generator. | c. Test generator (paragraph 7-2). |
| 18. Reverse power indicator DS5 (in parallel operation). | a. Defective or improperly adjusted utility governor. | a. Adjust or repair if defective (paragraph 8-127 or 8-132). |
| | b. Defective governor linkage. | b. Repair linkage (paragraph 8-127). |
| | c. Defective precise governor actuator (precise generator sets). | c. Test and repair if defective (paragraph 8-110 or '8-115). |
| | d. Defective governor control unit (precise generator sets). | d. Test and repair if defective (paragraph 6-216). |
| 19. Over voltage indicator DS6. | a. Defective exciter regulator. | a. Test exciter regulator (paragraph 6-67). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 20. Coolant temperature high indicator DS7. | a. Clogged or defective radiator. | a. Clean or repair radiator (paragraph 4-10). |
| | b. Defective water pump. | b. Repair pump (paragraph 8-119). |
| | c. Incorrect fuel injection timing. | c. Reset timing (paragraph 8-140). |
| | d. Clogged engine coolant passages. | d. Clean passages (paragraph 8-230). |
| | e. Defective shutter. | e. Repair shutter (paragraph 4-31). |
| 21. Overload indicator DS9. | a. Defective relay (K14). | a. Test relay (paragraph 6-157). |
| 22. Under frequency indicator DS10 (precise generator sets). | a. Defective precise governor actuator (precise generator sets). | a. Test and repair if defective (paragraph 8-110 or 8-115). |
| | b. Defective governor control unit (precise generator sets). | b. Test and repair if defective (paragraph 6-216). |
| 23. Generator set operates properly but fault locator indicators illuminate. | a. Defective fault locator. | a. Test and repair if defective (paragraph 6-49). |
| 24. Generator set shuts down, low fuel indicator illuminates but sufficient fuel is available for operation. | a. Defective dc relay assembly, A5 relay K8, in mode I relay box. | a. Test relay (paragraph 6-189). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 25. Generator set shuts down, overspeed indicator illuminates but engine was operating at normal speed. | a. Defective or improperly adjusted overspeed switch. | a. Repair or adjust switch (paragraph 8-46 or 8-51). |
| 26. Load contactor opens and overload indicator illuminates with no overload fault. | a. Defective overload relay K14. | a. Test relay (paragraph 6-157). |
| | b. Defective current transformer CT1, CT2, or CT3. | b. Test and replace if defective (paragraph 6-124). |
| 27. Overload fault condition exists but load contactor does not open. | a. Defective overload relay K14. | a. Test relay (paragraph 6-157). |
| | b. Defective thermal watt converter. | b. Test and replace if defective (paragraph 6-3). |
| | c. Defective current transformer CT1, CT2, or CT3. | c. Test and replace if defective (paragraph 6-124). |
| 28. Short circuit fault condition exists but load contactor does not open. | a. Defective short circuit relay K13. | a. Test relay (paragraph 6-148). |
| | b. Defective current transformers CT1, CT2, or CT3. | b. Test and replace if defective (paragraph 6-124). |
| | c. Defective thermal watt converter. | c. Test and replace if defective (paragraph 6-3). |
| | d. Defective current transformers CT4, CT5, or CT6. | d. Test and replace if defective (paragraph 6-124). |
| | e. Defective exciter regulator. | e. Test exciter regulator (paragraph 6-67). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 29. Over voltage fault condition exists but load contactor does not open. | a. Defective over voltage relay K2. | a. Test relay (paragraph 6-130). |
| 30. Under voltage fault condition exists but load contactor does not open (precise generator sets). | a. Defective under voltage relay K11. | a. Test relay (paragraph 6-180). |
| 31. Under frequency fault exists but load contactor does not open (precise generator sets). | a. Defective under frequency relay (K12). | a. Test relay (paragraph 6-171). |
| 32. Load contactor opens and reverse power indicator illuminate with no reverse power fault. | a. Defective load measurement unit. | a. Test unit (paragraph 6-227). |
| | b. Defective reverse power relay. | b. Test and replace relay (paragraph 6-139). |
| 33. Generator sets do not parallel properly (precise generator sets). | a. Precise governor system not properly aligned. | a. Align system (paragraph 6-225). |
| | b. Defective governor control unit. | b. Test and repair if defective (paragraph 6-216). |
| | c. Defective load measurement unit. | c. Test unit (paragraph 6-227). |
| | d. Defective permissive paralleling relay. | d. Test relay (paragraph 6-207). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 34. Attempting to parallel, without output connected for 120/208 VAC, synchronizing lights are very dim. | a. Defective mode I relay box. | a. Test relay box (paragraph 6-88). |
| 35. During parallel operation, circuit breaker of set number 2 will not close. | a. Defective circuit breaker. | a. Test and replace if defective (paragraph 6-105). |
| | b. Defective permissive paralleling relay K16 (precise generator sets). | b. Test relay (paragraph 6-189). |
| | c. Defective dc relay assembly, A5 in mode I relay box. | c. Test relay (paragraph 6-88). |
| 36. During parallel operation, generator sets do not share total KVA equality. | a. Defective or improperly adjusted KVA rheostat R29. | a. Adjust or replace rheostat (paragraph 6-88). |
| | b. Defective parallel receptacles. | b. Replace receptacles (paragraph 5-5). |
| | c. Defective mode I relay box. | c. Test relay box (paragraph 6-88). |
| | d. Defective exciter regulator. | d. Test exciter regulator (paragraph 6-67). |
| | e. Defective current transformers CT4, CT5, or CT6. | e. Test and replace if defective (paragraph 6-124). |
| | f. Defective generator. | f. Test and repair if defective (paragraph 7-2). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 37. During parallel operation, generator sets do not share real load (KW) equally (precise generator sets). | a. Defective or improperly adjusted real load sharing rheostat R28. | a. Adjust or replace rheostat (paragraph 6-218). |
| | b. Precise governor system not properly aligned. | b. Align system (paragraph 6-225). |
| | c. Defective current transformers CT1, CT2, or CT3. | c. Test and replace if defective (paragraph 6-124). |
| | d. Defective tactical relay box. | d. Test relay box (paragraph 6-162). |
| | e. Defective exciter regulator. | e. Test exciter regulator (paragraph 6-67). |
| 38. During parallel operation, generator sets do not share real load (KW) equally (utility generator sets). | a. Defective or improperly adjusted utility governor. | a. Adjust or repair governor (paragraph 8-132). |
| | b. Defective governor linkage. | b. Repair linkage (paragraph 8-132). |
| 39. Engine misses or runs erratically. | a. Incorrect fuel injection timing. | a. Reset timing (paragraph 8-140). |
| | b. Sticking valves. | b. Free valves (paragraph 8-184). |
| | c. Broken rocker arm assembly. | c. Replace rocker arm (paragraph 8-184). |
| | d. Cracked cylinder liner. | d. Replace liner (paragraph 8-230). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| | GENERATOR SET (Continued) | |
| 39. Engine misses or runs erratically. (continued) | e. Blown head gasket. | e. Replace gasket (paragraph 8-182). |
| | f. Broken valve spring. | f. Replace spring (paragraph 8-182). |
| | g. Defective fuel injection nozzle. | g. Replace nozzle (paragraph 8-135). |
| | h. Defective fuel injection pump. | h. Repair pump (paragraph 8-135). |
| | i. Bend or broken push rod. | i. Replace push rod (paragraph 8-182). |
| | j. Defective piston or rings. | j. Replace piston or rings (paragraph 8-214). |
| 40. Engine hunts (presise generator sets). | a. Defective exciter regulator | a. Test and replace if defective (paragraph 6-67). |
| | b. Defective or improperly adjusted governor actuator feedback transducer. | b. Test and adjust transducer (paragraph 6-215). |
| | c. Defective electronic component assembly, A26 in precise relay box. | c. Replace assembly (paragraph 6-208). |
| | d. Defective governor actuator. | d. Test and repair if defective (paragraph 8-110). |
| | e. Defective control unit. | e. Test and repair if defective (paragraph 6-216). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| **GENERATOR SET (Continued)** | | |
| 40. Engine hunts (precise generator sets). (continued) | f. Defective hydraulic pump. | f. Test and replace if defective (paragraph 8-94 and 8-98). |
| 41. Sluggish governor actuator operation (precise generator sets). | a. Low hydraulic pressure to actuator. | a. Test pump (paragraph 8-98). |
| | b. Defective governor linkage. | b. Repair linkage (paragraph 110). |
| | c. Defective precise governor actuator. | c. Test and repair if defective (paragraph 8-94 or 8-98). |
| | d. Defective governor control unit. | d. Test and repair if defective (paragraph 6-237). |
| | e. Defective hydraulic pump. | e. Test and replace if defective (paragraph 8-94 or 8-98). |
| 42. Engine lacks power. | a. Defective fuel nozzle. | a. Replace fuel nozzle (paragraph 8-135). |
| | b. Incorrect fuel injection timing. | b. Reset timing (paragraph 8-140). |
| | c. Blown head gasket. | c. Replace gasket (paragraph 8-182). |
| | d. Defective valves or valve springs. | d. Repair or replace valves or springs (paragraph 8-182). |
| | e. Defective piston, rings, or connecting rods. | e. Replace piston, rings, or connecting rods (paragraph 8-214). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 42. Engine lacks power. (continued) | f. Defective cylinder liner. | f. Replace liner (paragraph 8-184). |
| | g. Turbocharger carboned or dragging. | g. Repair turbocharger (paragraph 8-71). |
| | h. Defective governor linkage. | h. Repair linkage (paragraph 8-127). |
| 43. Engine knocks, develops excessive noise, or vibration. | a. Loose or defective crankshaft pulley or vibration damper. | a. Tighten or replace pulley or damper (paragraph 8-71). |
| | b. Defective or loose fan. | b. Tighten or replace fan (paragraph 8-31). |
| | c. Loose or defective engine mounts. | c. Tighten or replace mount (paragraph 8-222). |
| | d. Defective crankshaft or bearings. | d. Replace crankshaft or bearings (paragraph 8-222). |
| | e. Defective connecting rod or bearings. | e. Replace rod or bearings (paragraph 8-214). |
| | f. Defective piston or pin. | f. Replace piston or pin (paragraph 8-214). |
| | g. Damaged timing gear train components. | g. Replace defective components (paragraph 8-222). |
| 44. Engine exhaust excessively black or gray. | a. Defective fuel nozzle. | a. Replace nozzle (paragraph 8-135). |
| | b. Incorrect fuel injection timing. | b. Reset timing (paragraph 8-140). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 45. Engine exhaust excessively white or blue. | a. Defective valve guides. | a. Repair cylinder head (paragraph 8-135). |
| | b. Defective piston rings. | b. Replace rings (paragraph 8-214). |
| | c. Incorrect fuel injection timing. | c. Reset timing (paragraph 8-140). |
| 46. Excessive engine oil consumption. | a. Excessive valve guide wear. | a. Repair cylinder head (paragraph 8-182). |
| | b. High oil temperature due to defective oil cooler. | b. Repair cooler (paragraph 8-79). |
| | c. Worn piston rings and/or cylinder liners. | c. Replace piston rings (paragraph 8-214) and/or cylinder liners (paragraph 8-236). |
| 47. Heavy engine combustion knock. | a. Defective fuel injection pump plunger and barrel assembly. | a. Replace plunger and barrel assembly (paragraph 8-135). |
| | b. Defective or leaking fuel injection valve. | b. Replace fuel injection valve (paragraph 8-135). |
| 48. Engine valve train clicking noise. | a. Defective valve spring. | a. Replace spring (paragraph 8-135). |
| | b. Insufficient lubrication in valve compartment. | b. Clean oil passages leading to the cylinder head (paragraph 8-183). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 49. Engine lubricating oil in coolant. | a. Defective cylinder head gasket. | a. Replace gasket (paragraph 8-182). |
| | b. Defective oil cooler core. | b. Repair or replace cooler (paragraph 6-79). |
| 50. Engine stalls at low speed. | a. Idle speed too low. | a. Adjust governor low idle setting (paragraph 8-131). |
| | b. Defective fuel injection valve. | b. Repair valve (paragraph 8-135). |
| 51. Loud valve train noise in engine. | a. Defective camshaft. | a. Replace camshaft (paragraph 8-198). |
| | b. Defective valve lifters. | b. Replace valve lifters (paragraph 8-182). |
| 52. Little rocker arm movement and excessive valve lash. | a. Defective camshaft and/or followers. | a. Replace camshaft and/or followers (paragraph 8-198). |
| | b. Defective valve lifters. | b. Replace lifters (paragraph 8-182). |
| | c. Defective push rod. | c. Replace rod (paragraph 8-182). |
| | d. Insufficient lubrication in valve compartment. | d. Clean oil passages leading to the cylinder head (paragraph 8-183). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 53. Engine valve roto-coil or spring retainer free. | a. Broken valve keepers. | a. Replace keepers (paragraph 8-182). |
| | b. Broken valve spring. | b. Replace valve spring (paragraph 8-182). |
| | c. Defective valve. | c. Replace valve (paragraph 8-182). |
| 54. Excessive engine blow-by. | a. Excessive valve guide wear. | a. Repair cylinder head (paragraph 8-182). |
| | b. Excessive lubricating oil in valve compartment. | b. Check rocker arm shaft end plugs for proper installation (paragraph 8-186). |
| | c. Worn piston rings and/or liners. | c. Replace piston rings (paragraph 8-214) and/or liners (paragraph 8-230). |
| 55. Coolant in engine lubricating oil. | a. Defective cylinder head gasket. | a. Replace gasket (paragraph 8-182). |
| | b. Defective cylinder head. | b. Replace head (paragraph 8-182). |
| | c. Defective combustion chamber. | c. Replace chamber (paragraph 8-182). |
| | d. Defective cylinder block. | d. Replace block (paragraph 8-230). |
| | e. Defective oil cooler. | e. Repair or replace oil cooler (paragraph 8-79). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 56. Alternator charging rate low or unsteady. | a. Intermittent or high resistance in charging or ground return circuits or battery connections. | a. Clean, retighten, or replace defective parts. |
| | b. Defective regulator. | b. Replace if defective (paragraph 8-14). |
| | c. Alternator rectifier diodes shorted or open. | c. Replace diodes (paragraph 8-14). |
| | d. Alternator rotor (field coil) turns grounded or shorted. | d. Replace rotor (paragraph 8-14). |
| | e. Loose connections on alternator and/or regulator. | e. Tighten connections. |
| | f. Defective brushes. | f. Replace brushes (paragraph 8-14). |
| 57. Noisy alternator. | a. Misaligned belt or pulley. | a. Align drive pulley and alternator pulley and belts. |
| | b. Loose pulley. | b. Tighten pulley nut, if keyway is worn, replace pulley (paragraph 8-14). |
| | c. Worn bearings. | c. Replace bearings (paragraph 8-14). |
| | d. Shorted rectifier diodes. | d. Replace diode assembly (paragraph 8-14). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| GENERATOR SET (Continued) | | |
| 58. Noisy turbocharger. | a. Worn bearings. | a. Replace bearings (paragraph 8-71). |
| | b. Insufficient lubrication. | b. Clean oil passages (paragraph 8-71). |
| | c. Excessive end play. | c. Repair turbocharger (paragraph 8-71). |
| | d. Defective shaft and wheel assembly. | d. Repair turbocharger (paragraph 8-71). |
| FUEL BURNING WINTERIZATION KIT | | |
| 59. Heater switch ON, nothing happens, press to test indicator energizes when depressed. | a. Thermostat switch defective. | a. Test and replace defective thermostat switch (paragraph 11-11). |
| | b. Heater switch defective. | b. Check continuity of switch. Replace if defective (paragraph 11-5). |
| 60. Switch on, heater will not ignite. Blower operates. | a. Heater orifice clogged. | a. Clean orifice. Replace if defective (paragraph 11-13). |
| | b. Fuel regulator valve solenoid closed. | b. Test and adjust fuel regulator valve (paragraph 11-13). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| FUEL BURNING WINTERIZATION KIT (Continued) | | |
| 61. Fan runs continuously with switch off. | a. Broken quartz rod. | a. Replace quartz rod (paragraph 11-11). |
| | b. Flame switch out of adjustment. | b. Readjust (paragraph 11-16). |
| | c. Wiring defective. | c. Check continuity of wiring. Replace if defective (figure 1-21). |
| 62. Heater starts, then shuts off. | a. Defective micro switch. | a. Test and replace micro switch if defective (paragraph 11-16). |
| | b. Heater overheats, causing limit switch to trip. | b. Check and adjust fuel flow rate by adjusting and testing regulator valve (paragraph 11-13). |
| 63. Circuit breaker trips open. | a. Short circuit. | a. Disconnect basic components one at a time, to isolate short, then check wiring (figure 1-21). |
| 64. Heater will not shut off. | a. Fuel regulator valve stuck open. | a. Test fuel regulator valve and replace if defective (paragraph 11-13). |
| | b. Flame switch stuck in RUN position. | b. Adjust flame switch and replace if defective (paragraph 11-16). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| FUEL BURNING WINTERIZATION KIT (Continued) | | |
| 65. Heater has surging combustion. | a. Fuel regulator operating irradically. | a. Test fuel regulator valve (paragraph 11-13). |
| | b. Defective sintered filter. | b. Clean filter. |
| 66. Coolant pump fails to recirculate liquid. | a. Defective coolant pump. | a. Test coolant pump (paragraph 11-16). |
| 67. Coolant pump turns over but fails to deliver liquid. | a. Pump passages or blade slots plugged with foreign matter. | a. Remove pump and disassemble and clean (paragraph 11-11). |
| 68. Heater has erratic operation or reduced output. | a. Air leaks in tubing. | a. Check tubing connections for leaks and repair as necessary (paragraph 11-11). |
| | b. Reduced voltage. | b. Check voltage input to motor. It should be above 24 vdc (figure 1-21). |
| | c. Motor lags, low rpm. | c. Inspect motor brushes for wear (paragraph 11-11). |
| | d. Scored cam ring bore. | d. Replace cam ring (paragraph 11-11). |
| | e. Foreign matter in pump blade slot. | e. Remove pump, disassemble and clean (paragraph 11-11). |
| 69. Heater leaks. | a. Face of seal cage scored or seal is damaged. | a. Disassemble pump and refinish or replace seal cage (paragraph 11-11). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| ELECTRIC WINTERIZATION KIT | | |
| 70. Switch on control box positioned to ON; heater ON indicator energized, coolant pump operating but coolant temperature not rising. | a. Defective electric heater. | a. Test electric heater and replace if defective (paragraph 12-14). |
| 71. Switch on control box positioned to ON; indicator energized but coolant not being circulated and coolant temperature not rising. | a. Defective thermo switch S2. | a. Check continuity of switch at room temperature. It should have continuity. Immerse its temperature sensing element in a water bath at a temperature of 120 + °F. There should be no continuity now. Allow water to cool below 100°F. There should be continuity again. |
| | b. Defective control box. | b. Test control box (paragraph 12-3). |
| | c. Defective heater. | c. Repair heater (paragraph 12-14). |
| | d. Defective coolant pump. | d. Test pump (paragraph 12-19). |
| 72. Switch on control box positioned to ON and indicator does not energize. | a. No power to input receptacle J49, terminals A and B, figure 1-30. | a. Remove cable and measure voltage to these two terminals. It should be between 205 to 240 VAC, 50/60 hertz. |
| | b. Defective control box. | b. Test control box (paragraph 12-3). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| DUMMY LOAD KIT | | |
| 73. Dummy load kit will not apply load when automatic load switch is in the ON position, but does apply load when switch is in BYPASS RESET position. | a. Defective load measuring unit.<br>b. Defective load dumping relay (K5).<br>c. Defective wiring harness. | a. Test and repair if defective (paragraph 6-227).<br>b. Test and repair if defective (paragraph 13-11).<br>c. Rebuild harness (paragraph 13-7 or 13-27). |
| 74. Dummy load kit trips off the line below automatic removal point. | a. Defective load dumping relay (K5).<br>b. Defective load measuring unit. | a. Test and repair if defective (paragraph 13-11).<br>b. Test and repair if defective (paragraph 6-227). |
| 75. Dummy load kit does not disconnect at automatic removal point. | a. Defective load dumping relay (K5).<br>b. Defective load measuring unit. | a. Test and repair if defective (paragraph 13-11).<br>b. Test and repair if defective (paragraph 6-227). |
| 76. Dummy load set does not apply load when automatic load switch is in either position. | a. Defective transformer (T1).<br>b. Defective bridge rectifier assembly CR1, CR2, CR3, or CR4.<br>c. Defective wiring harness. | a. Test and replace if defective (paragraph 13-25).<br>b. Test and replace if defective (paragraph 13-25).<br>c. Rebuild harness (paragraph 13-7 or 13-27). |

Table 2-3. Troubleshooting (Continued)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| DUMMY LOAD KIT (Continued) | | |
| 77. Dummy load kit Load does not change change when load selector switch is rotated. | a. Defective contactor K1, K2, K3, or K4. | a. Test and replace if defective (paragraph 13-25). |
| 78. Dummy load is unbalanced. | a. Defective contactor K1, K2, K3, or K4. | a. Test and replace if defective (paragraph 13-25). |
| | b. Defective heater elements. | b. Test and replace if defective (paragraph 13-5). |
| | c. Defective wiring harness. | c. Test and repair if defective (paragraph 13-7 or 13-27). |

## Section III. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS AND AUXILIARIES

### 2-5. GENERAL.

This section contains instructions for the removal and installation of major components of the generator set to facilitate repair and overhaul. Detailed maintenance procedures for these components are contained in subsequent sections of this technical manual.

### 2-6. CONTROL CUBICLE.

a. Removal. Refer to figure 2-2 and remove control cubicle as follows:

1. Disconnect harness from control cubicle.

2. Disconnect control cubicle from rear housing by removing screws and washers. Remove control cubicle.

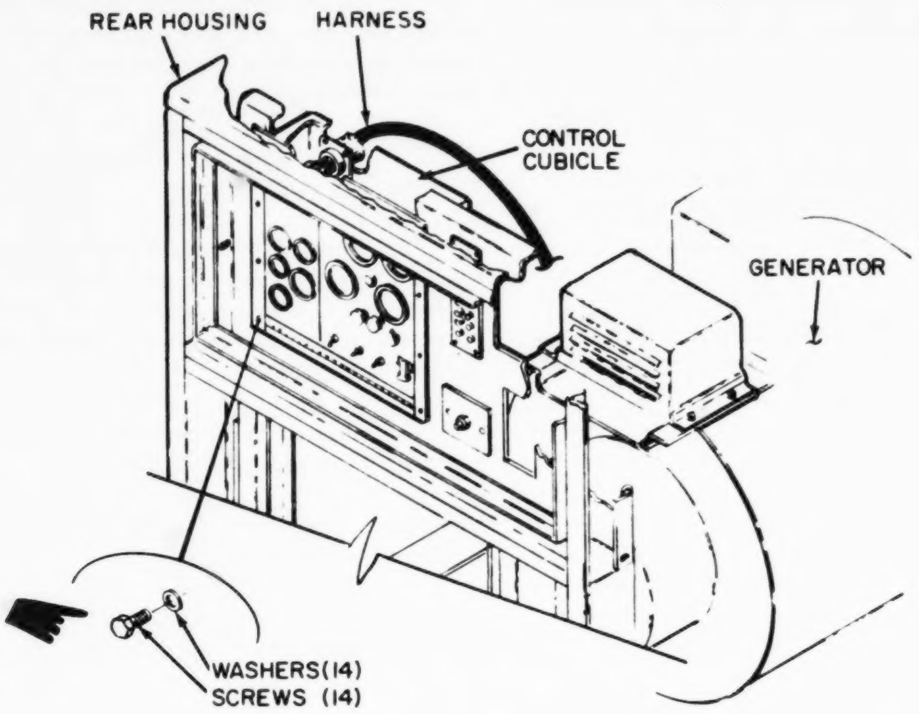


Figure 2-2. Control cubicle, removal and installation

b. Installation. Refer to figure 2-2 and install control cubicle as follows:

1. Install control cubicle in rear housing and secure with screws and washers.

2. Connect electrical harness to control cubicle connector.

## 2-7. GENERATOR.

a. Removal. Remove generator as follows:

1. Refer to Operator and Organizational Maintenance Manual and perform the following:

(a) Disconnect negative battery cable.

(b) Drain fuel tank.

(c) Remove rear housing cover and rear generator compartment access doors.

(d) Remove air cleaner.

(e) Tag and disconnect wiring harnesses from fault locator, DC control circuit breaker, control cubicle, convenience receptacle, exciter regulator, mode I relay box, load measurement unit, tactical relay box, precise relay box (precise generator sets only), circuit breaker assembly, and kit control boxes, if installed.

(f) Disconnect parallel receptacle wiring harness from rear housing.

(g) Remove manual speed control.

2. Remove stowage box from skid base on left side of generator by removing three screws, washers, and nuts.

3. Refer to figure 2-3 and remove upper (19) and lower (20) side housings and assembled rear housing (18) in the order of index numbers assigned.

4. Remove fuel tank from skid base as follows:

(a) Remove lower rear panel (26) and filler panel (24 and 25) from skid base as an assembly by removing screws (21), lock washers (22), and washers (23).

(b) Remove rear fuel tank retainers (29) from skid base by removing screws (28), and nuts (27).

(c) Remove oil drain coupling assembly (33) from skid base by removing nuts (30), washers (32), and screws (31) to insure no interference of oil drain hose on tank removal.

(d) Disconnect ground lead (37) from skid base by removing nut (34), load terminal (36), and lock washers (35).

(e) Loosen clamp (38) and remove fuel filler hose (39) from tank.

(f) Disconnect electrical connector (40) from fuel level transmitter (41) on fuel tank.

(g) Tag and disconnect fuel and vent lines from fuel tank and plug lines.

(h) Remove fuel tank retaining straps (46) securing fuel tank to skid base by removing nuts (42), washers (43) and wedge washers (44).

(i) Remove fuel tank from the skid base through rear opening.

5. Remove bracket from generator and load board frame by removing two screws, nuts, and lock washers from load board frame and two screws and lock washers from generator.

6. Refer to figure 2-4 and remove load board assembly (10) as follows:

(a) Remove protective cover (2) by loosening studs (1).

(b) Remove brackets (5) by removing screws (3) and lock washers (4).

(c) Remove screws (6) and lock washers (7). Move load board assembly (10) away from frame.

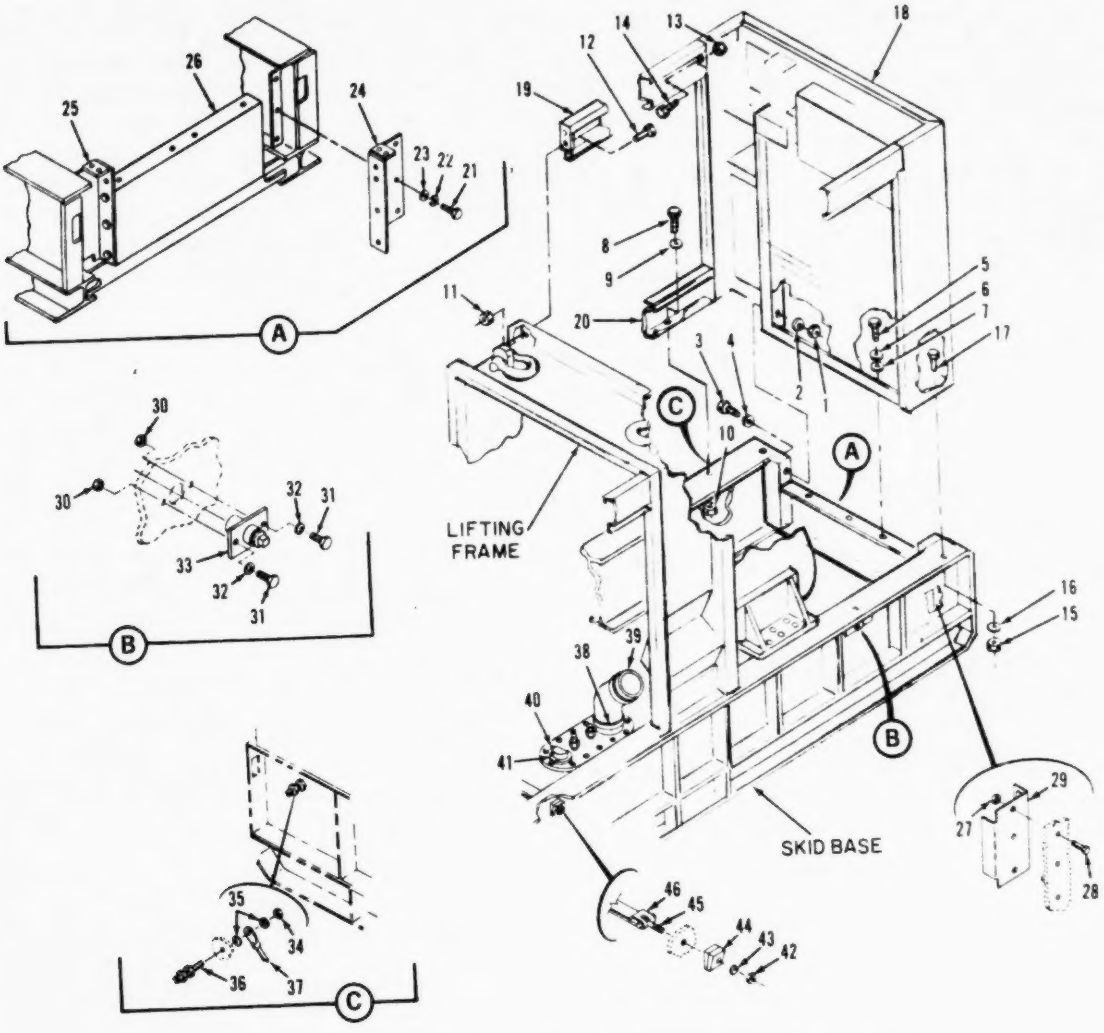
NOTE

Tag and identify electrical leads to insure proper installation.

(d) Remove electrical leads from load board assembly (10) by removing nuts (8) and lock washers (9).

7. Remove transformer assembly cover (12) by removing screws (11).

8. Remove brace and wrench assembly (19) by removing screws (13 and 16), nuts (14 and 17), and lock washers (15 and 18).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SKID BASE
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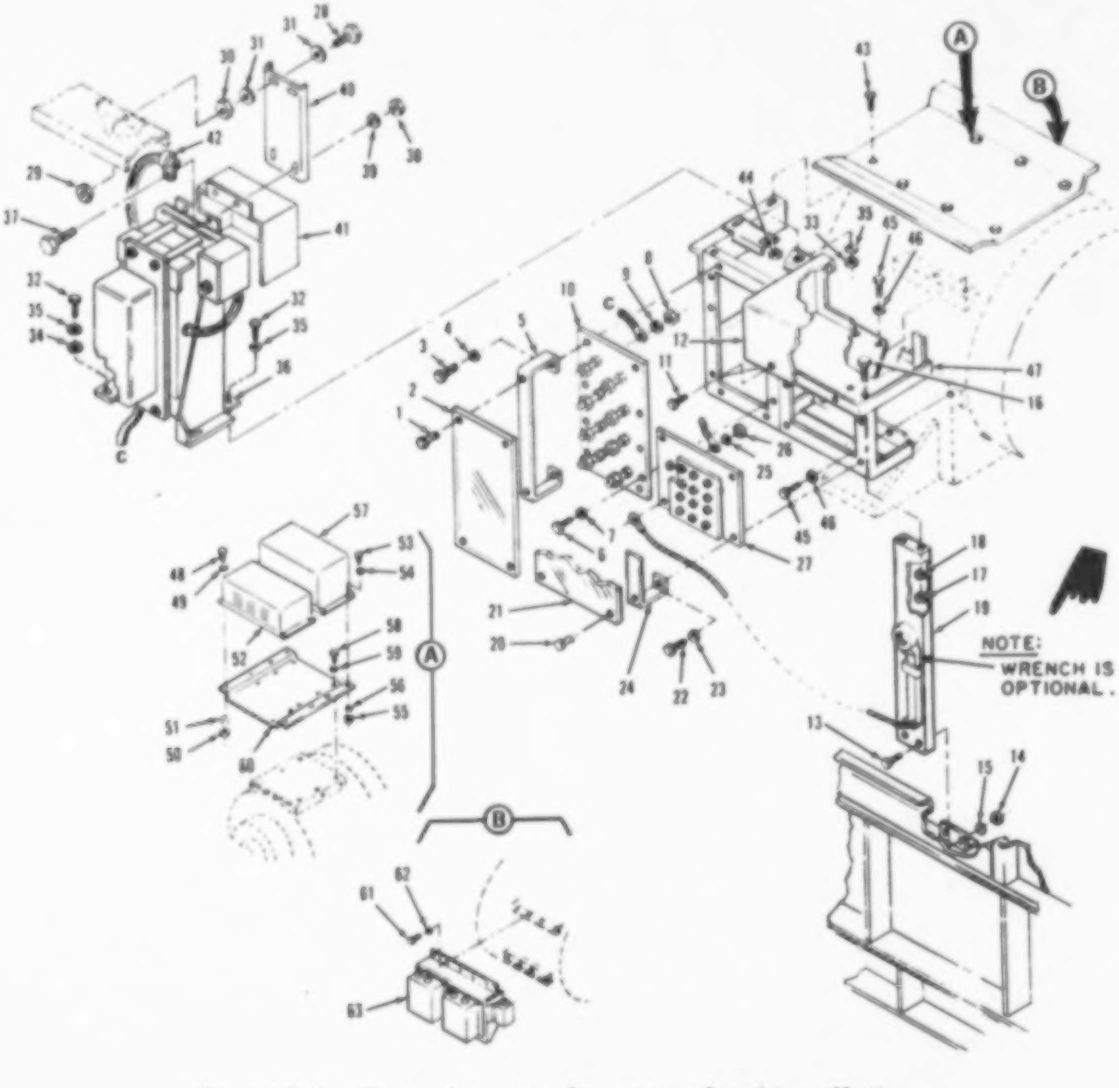
Figure 2-3. Rear housing, upper and lower sides housing, removal and installation

Legend to figure 2-3:

1. Nut (2)
2. Lock washer (2)
3. Screw (2)
4. Washer (2)
5. Screw (4)
6. Lock washer (4)
7. Washer (4)
8. Screw (10)
9. Washer (10)
10. Nut (10)
11. Nut (8)
12. Screw (8)
13. Nut (8)
14. Screw (8)
15. Nut (4)
16. Lock washer (4)
17. Screw (4)
18. Rear housing
19. Upper side housing (2)
20. Lower side housing (2)
21. Screw (6)

Legend to figure 2-3: continued

22. Lock washer (6)
23. Washer (6)
24. Filler panel
25. Filler panel
26. Lower rear panel
27. Nut (6)
28. Screw (6)
29. Fuel tank retainer
30. Nut (2)
31. Screw (2)
32. Washer (2)
33. Coupling assembly
34. Nut
35. Lock washer (2)
36. Load terminal
37. Ground lead
38. Clamp
39. Fuel filler hose
40. Electrical connector
41. Fuel level transmitter
42. Nut (4)
43. Lock washer (4)
44. Bevel washer (8)
45. Tee bolt (4)
46. Retaining strap (2)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NOTE: WRENCH IS OPTIONAL.

Figure 2-4. Generator controls, removal and installation

Legend to figure 2-4:

1. Stud (4)
2. Protective cover
3. Screw (4)
4. Lock washer (4)
5. Bracket (2)
6. Screw (8)
7. Lock washer (8)
8. Nut (8)
9. Lock washer (8)
10. Load board a assembly
11. Screw (6)
12. Transformer assembly cover
13. Screw (4)
14. Nut (4)
15. Lock washer (4)
16. Screw (2)
17. Nut (2)
18. Lock washer (2)
19. Brace and wrench assembly
20. Stud (4)
21. Protective cover
22. Screw (4)
23. Lock washer (4)
24. Bracket (2)
25. Nut (12)
26. Lock washer (12)
27. Reconnection board assembly
28. Screw (2)
29. Nut (2)
30. Nut (2)
31. Washer (4)
32. Screw (4)
33. Nut (4)
34. Lock washer (4)
35. Washer (4)
36. Circuit breaker assembly
37. Screw (2)
38. Nut (2)
39. Washer (2)
40. Brace
41. Shield
42. Clamp
43. Screw
44. Nut
45. Screw (5)
46. Lock washer (5)
47. Transformer assembly with frame
48. Screw (4)
49. Washer (4)
50. Nut (4)
51. Lock washer (4)
52. Exciter regulator
53. Screw (4)
54. Washer (4)
55. Nut (4)
56. Lock washer (4)
57. Mode I relay box
58. Screw (6)
59. Washer (6)
60. Bracket
61. Screw (8)
62. Lock washer (8)
63. Relay box and bracket assembly

*Precise relay box is utilized on 50/60 hertz precise generator sets only.

9. Remove reconnection board assembly (27) as follows:

(a) Remove protective cover (21) by loosening studs (20).

(b) Remove brackets (24) by removing screws (22) and lock washers (23). Move reconnection board assembly (27) away from frame as far as possible.

NOTE

Tag and identify electrical leads to insure proper installation.

(c) Remove electrical leads from rear of reconnection board assembly by removing nuts (25) and lock washers (26).

10. Remove circuit breaker assembly (36) as follows:

NOTE

Exercise care when removing circuit breaker assembly to prevent chafing of electrical leads.

(a) Remove screws (28), nuts (29 and 30) and washers (31) that secure circuit breaker assembly (36) to frame.

(b) Remove screws (32), nuts (33) and washers (34 and 35). Remove circuit breaker assembly (36) with attaching electrical leads.

(c) Remove brace (40) shield (41) and clamp (42) from circuit breaker assembly (36) by removing screws (37), nuts (38) and washers (39).

11. Tag and disconnect relay box to reconnection board wiring harness from connector J61 of the generator and terminals of TB2 located on transformer assembly (36).

12. Remove generator leads from transformer assembly (47).

13. Remove transformer assembly (47) by removing screws (43 and 45), lock washers (46) and nuts (44).

14. Remove exciter regulator (52) and mode I relay box (57) by removing screws (48 and 53), washers (49 and 54), nuts (50 and 55), and lock washers (51 and 56).

15. Remove bracket (60) by removing screws (58) and washers (59).

16. Remove relay box and bracket assembly (63) by removing screws (61) and lock washers (62).

17. Refer to figure 2-5 and disconnect screen (4) by removing nuts (1), lock washers (2), and screws (3).

CAUTION

Rotate engine crank shaft as required to gain access to screws (5). Do not attempt to rotate generator by prying on generator fan.

NOTE

To bar engine, see figure 2-6 and remove four screws, four washers and cover from the hydraulic pump drive. Place a 1 1/8 inch (28.575 mm) box wrench on shaft and rotate shaft either clockwise or counterclockwise as required.

18. Straighten corners of locking plates (6) and remove screws (5) and locking plates. Rotate engine using engine barring method as required for access to screws (5).

19. Connect a suitable overhead lifting device to both generator lifting eyebolts and remove slack from lifting device.

20. Remove nuts (7), washers (9), and screws (8) securing generator to skid base.

21. Turn engine support bolts (16) clockwise to contact skid base.

22. Install two suitable wooden blocks, 180 degrees apart, between generator frame and generator fan to prevent main rotor assembly from sliding out of frame during lifting. Remove screws (10) and lock washers (11).

WARNING

Stay clear of generator during lifting operations.

23. Move generator back away from engine, far enough to clear engine turbocharger. Lift generator with overhead device clear of skid base.

24. Lower generator to floor and block generator to prevent tipping, remove lifting device from generator.

25. Remove wooden blocks installed between generator frame and fan. Secure fan to shaft couplings with two nuts and screws 180 degrees apart.

26. Install screen (4) on generator with screws (3), lock washers (2), and nuts (1).

27. Install a suitable moving block (refer to figure 2-1 view A) across engine mounting end of generator frame to support main rotor assembly and prevent it from sliding out of frame during movement.

28. Place tag on generator stating; fan mounted to shaft coupling with two screws and nuts for mounting purposes only.

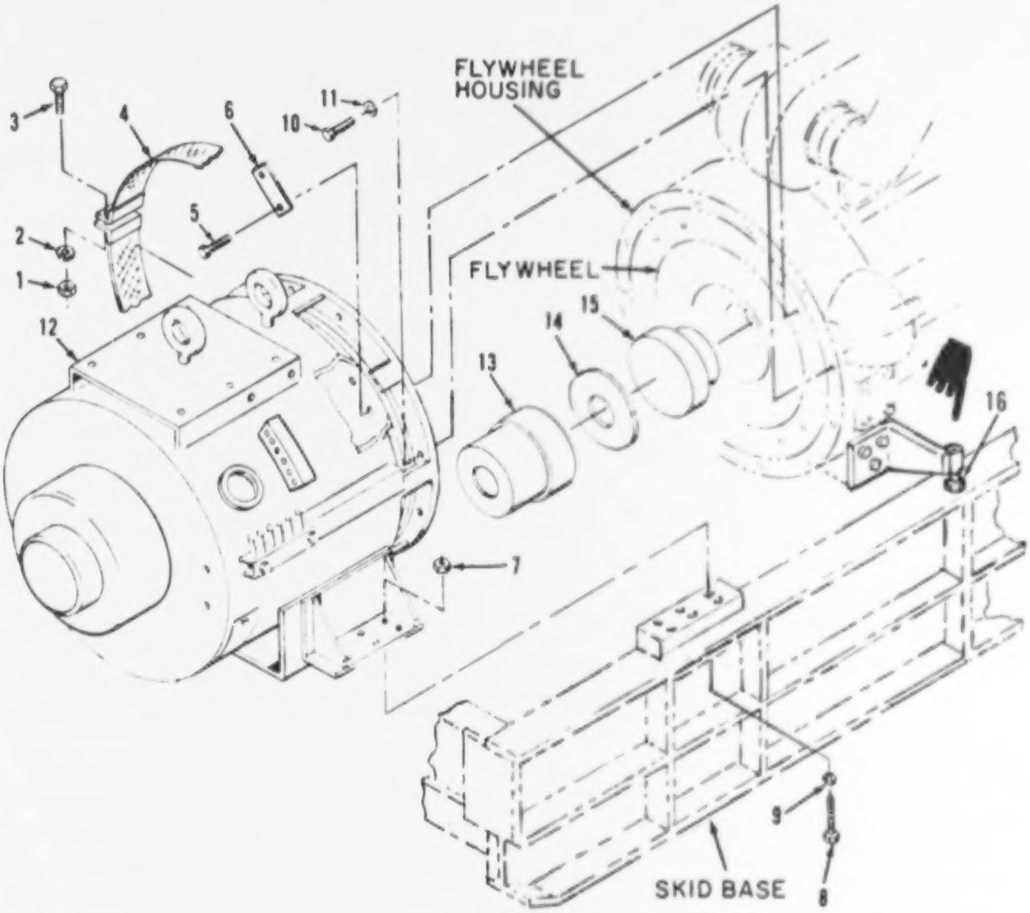
FLYWHEEL HOUSING
FLYWHEEL
SKID BASE
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Figure 2-5. Generator, removal and installation

Legend to figure 2-5:

1. Nut (2)
2. Lock washer (2)
3. Screw (2)
4. Screen
5. Screw (8)
6. Locking plate (4)
7. Nut (12)
8. Screw (12)
9. Washer (12)
10. Screw (12)
11. Lock washer (12)
12. Generator
13. Spacer
14. Spring washer
15. Spacer
16. Engine support bolt (2)

29. If necessary, remove spacers (13 and 15) and spring washer (14) from engine flywheel.

b. Installation. Install generator as follows:

1. Move generator as close to generator set as possible. Remove shipping blocks.

2. Make sure spacers (13 and 15) and spring washer (14) are installed in flywheel. Clean flywheel with an approved cleaning solvent and dry thoroughly. Inspect flywheel for nicks and burrs. Remove nicks and burrs using a suitable file or stone.

3. Remove screen (4) from generator. If fan is bolted to shaft couplings, remove shipping screws and nuts.

4. Inspect generator shaft couplings for ragged edges and burrs. Touch up ragged edges and burrs with a suitable file, exercising care to remove burrs and ragged edges only. Clean shaft couplings with an approved cleaning solvent and dry thoroughly.

5. Install two suitable wooden blocks, 180 degrees apart, between generator frame and fan to prevent main rotor assembly from sliding out of frame during installation.

6. Connect a suitable overhead lifting device to both generator lifting eyebolts.

WARNING

Stay clear of generator during lifting.

NOTE

Adjust engine support bolts if required.

7. Position generator against flywheel housing and secure generator with two screws (10) and washers (11), 180 degrees apart.

8. Remove wooden blocks from generator frame. Rotate engine crankshaft using engine barring device as required to align flywheel generator shaft coupling holes with holes in shaft couplings. After holes are aligned, push generator shaft couplings against engine flywheel, making sure couplings are inside of flywheel recess.

NOTE

Rotate engine crankshaft as required to gain access to screws.

9. Position generator fan on rear of shaft couplings and install locking plates (6) and screws (5). Tighten screws evenly in a criss-cross pattern. Torque screws to 150 foot-pounds (20.749 Kg meters). Bend corners of locking plates (6) against screws (5) to prevent screws from turning.

10. Install remaining screws (10) and washers (11). Tighten screws evenly. Torque screws to 75 foot-pounds (10.372 Kg meters).

11. Remove overhead lifting device and turn engine support bolts (16) so that bolts are clear of frame.

NOTE

Push generator toward radiator if generator mount holes do not align.

12. Install screws (8), lock washers (9), and nuts (7). Hold generator mounting bolts stationary and tighten nuts (7) to 600 foot-pounds (82.98 Kg meter) torque.

NOTE

Generator air gap should be 0.125 inch (3.175 mm).

13. Check generator air gap using a 0.125 inch feeler gage and feeler gage holder FB-312 (3.175 mm) (Manufactured by Snap-On Tools Corp., Kenosha, Wisconsin) or equivalent. Insert gage through opening between generator frame and fan. Position gage between main stator and main rotor, making sure gage is positioned on high point of stator pole splices. Hold gage stationary and rotate engine and generator approximately three revolutions by turning engine crankshaft. Measure clearance around main stator and main rotor at three equally spaced locations. There should be no evidence of interference. If interference is indicated, generator is defective or engine flywheel is not concentric.

14. Install screen (4) and secure with screws (3), washer (2), and nuts (1).

15. Refer to figure 2-4 and install relay box and bracket assembly (63) and secure with screws (61) and lock washers (62).

16. Install bracket (60) and secure with screws (58) and washers (59).

17. Install exciter regulator (52 and mode I relay box (57) and secure with screws (48 and 53), washers (49 and 54), nuts (50 and 55), and lock washers (51 and 56).

18. Install transformer assembly (47) and secure with screws (43 and 45), lock washers (46), and nuts (44).

NOTE

For wire routing and termination refer to Operator and Organizational Maintenance Manual.

19. Route generator leads through transformer assembly (47).

20. Connect relay box to reconnection board wiring harness from connector J61 of the generator and terminals of TB-2 located on transformer assembly (47).

21. Refer to figure 2-4 and install circuit breaker assembly (36) as follows:

(a) Install shield (41), brace (40) and clamp (42) on circuit breaker assembly (36) with screws (37), nuts (38) and washers (39).

NOTE

Exercise care when installing electrical leads to prevent chafing.

(b) Route circuit breaker assembly (36) electrical leads to location. Secure base of circuit breaker assembly (36) to frame with screws (32), washers (34 and 35) and nuts (33).

(c) Secure circuit breaker assembly brace (40) to frame with screws (28), washers (31) and nuts (29 and 30).

22. Position reconnection board assembly (27) close to frame and secure electrical leads with lock washers (26) and nuts (25). Install brackets (24) and secure reconnection board assembly (27) to frame with screws (22) and lock washers (23). Install protective cover (21) and secure with studs (20).

23. Install brace and wrench assembly (19) and secure with screws (13 and 16), lock washers (15 and 18), and nuts (14 and 19).

24. Install transformer assembly cover and secure with screws (11).

25. Position load board assembly (10) close to frame and secure electrical leads with lock washers (9) and nuts (8). Install brackets (5) and secure load board assembly

(10) to frame with lock washers (4) and screws (3). Install protective cover (2) and secure with studs (1).

26. Install bracket between generator (12), and load board frame and secure with four screws (32), lock washers (35), and two nuts (44).

27. Install fuel tank as follows:

(a) Position fuel tank in skid base and secure with retaining straps (46, figure 2-3) nuts (42), washers (43), and wedge washers (44).

(b) Install fuel and vent lines on fuel tank.

(c) Install electrical connector (40) to fuel level transmitter (41) on tank.

(d) Install fuel filler hose (39) on tank and secure with clamp (38).

(e) Connect ground lead (37) on skid base and secure with nut (34), lock washers (35) and load terminal (36).

(f) Install oil drain coupling assembly (33) in skid base and secure with screws (31), washers (32), and nuts (30).

(g) Install rear fuel tank retainer (29), on skid base and secure with screws (28) and nuts (27).

(h) Install lower rear panel (26) and filler panels (24 and 25) on skid base and secure with screws (21), lock washers (22), and washers (23).

28. Refer to figure 2-3 and install upper and lower side housings (19 and 20) and rear housing (18) in the reverse order of index numbers assigned.

29. Install stowage box on skid base on left side of generator with three screws, washers, and nuts.

30. Refer to Operator and Organizational Maintenance Manual and perform the following:

(a) Install and adjust manual speed control.

(b) Connect parallel receptacle wiring harness to rear housing.

(c) Connect wiring harnesses to fault locator, DC control circuit breaker, control cubicle, convenience receptacle, exciter regulator, mode I relay box, load measurement unit, tactical relay box, precise relay box (precise generator sets only), circuit breaker assembly, and kit control boxes, if installed.

(d) Install air cleaner.

(e) Install rear housing cover and generator compartment access doors.

(f) Service fuel system.

(g) Connect negative battery cable.

## 2-8. ENGINE.

a. Removal. Remove the engine as follows:

1. Refer to Operator and Organizational Maintenance Manual and perform the following:

(a) Disconnect negative battery cable. Tag and disconnect cables from slave receptacles SR1 and SR2. Remove starter ground cable from skid base.

(b) Drain fuel filter and strainer, secondary fuel filter, day tank, radiator, engine lubricating oil, and hydraulic tank on precise generator sets.

(c) Disconnect muffler clamps from front housing cover. Remove front and rear housing covers and engine and generator access doors.

(d) Remove muffler, exhaust pipe, and crankcase breather hose assembly.

(e) Remove fan guard, fan, and radiator and shutter assembly.

(f) Disconnect manual speed control from utility governor.

(g) If installed, remove winterization kit heaters and coolant lines from oil pan heat exchanger tubes and engine block. Disconnect kit harnesses from control boxes and coil harness on engine.

(h) Tag and disconnect engine harness from connector J5 of mode I relay box, connector J39 of DC control circuit breaker, connector J33 of the day tank float switch, connector J38 of the ether primer and fuel tank fuel level transmitter. Cut tiedown strap securing engine harness to other harnesses. Coil engine harness wires and secure wires to engine.

(i) Disconnect ether starting air tube from intake manifold.

(j) Tag and disconnect electrical leads from radio suppression diode assembly mounted to day tank.

2. Disconnect four upper side housing members from lifting frame by removing sixteen screws and nuts securing members to lifting frame.

(a) Remove two members from rear housing by removing four screws and washers.

3. Disconnect engine oil drain hose from engine oil drain valve at left side of engine. Plug hose and valve opening.

4. Remove engine block coolant drain hose from right side skid base fitting.

5. Remove stowage box from skid base by removing three screws, washers, and nuts.

6. Loosen clamp and remove fuel filler hose from fuel tank. Cover fuel tank opening. Disconnect fuel tank vent hoses from fuel filler neck. Tag and disconnect fuel hoses from fuel transfer valve, auxiliary fuel inlet fitting, fuel supply outlet fitting and day tank. Remove supply hose from electric fuel transfer pumps. Plug hoses and openings. Disconnect two clamps securing hoses to lifting frame; one clamp is located on each inside wall of lifting frame.

NOTE

Governor control unit is mounted to lifting frame on the right side.

7. On precise generator sets, tag and disconnect connectors from governor control unit. Remove harness from connector P8 of the precise relay box, cut tiedown strap and coil harness on engine. Disconnect governor control unit and mount from lifting frame by removing four screws, washers, and nuts.

8. Remove sixteen screws, washers, and nuts securing lifting frame to skid base. Using a suitable lifting device, remove lifting frame from generator set.

9. Disconnect screen (4, figure 2-5) by removing nuts (1), washers (2), and screws (3).

CAUTION

Rotate engine crankshaft as required to gain access to screws. Do not attempt to rotate generator by prying on generator fan or flywheel ring gear.

10. Straighten corners of locking plates (6) and remove screws (5) and locking plates. Rotate engine using engine barring device as required for access to screws (5).

11. Turn engine support bolts (16) to contact skid base to support engine.

12. Connect a suitable overhead lifting device to both engine lifting eyebolts (figure 2-6). Remove slack from lifting device.

13. Remove screws (10, figure 2-5) and washers (11) securing generator to flywheel housing.

14. Disconnect engine trunnion mount from engine support by removing bolts and washers (figure 2-6).

15. Move engine forward until free of generator. Remove engine from generator set. Place engine on stand, cradle, or crib and block.

16. If necessary, remove spacers (13 and 15, figure 2-5) and spring washer (14) from flywheel.

17. Plug all engine openings and steam clean engine.

b. Installation. Install the engine as follows:

1. Move engine as close to generator set as possible.

2. Connect a suitable lifting device to both engine lifting eyebolts (figure 2-6).

3. Inspect flywheel for nicks and burrs on generator contact surfaces. Remove nicks and burrs using a suitable file or stone. Clean flywheel with an approved cleaning solvent and dry thoroughly.

4. Inspect generator shaft couplings for ragged edges and burrs. Touch up ragged edges and burrs with a suitable file, exercising care to remove burrs and ragged edges only. Clean shaft couplings with an approved cleaning solvent and dry thoroughly.

5. Insert spacers (13 and 15, figure 2-5) and spring washer (14) in flywheel.

WARNING

Stay clear of engine during lifting operations.

6. Position engine in generator set, aligning engine flywheel housing screw holes with generator frame holes. Install four screws (10, figure 2-5) and lock washers (11), 90 degrees apart.

7. Align engine trunnion mount holes with engine support holes. Secure trunnion mount to engine support with bolts and washers and tighten engine mount bolts to 200 foot-pounds (27.66 Kg meters) torque (figure 2-6).

8. Remove lifting device.

NOTE

To bar engine, see figure 2-6 and remove four screws, four washers and cover from the hydraulic pump drive. Place a 1 1/8 inch (28.575 mm) box wrench on shaft and rotate shaft either clockwise or counterclockwise as required.

9. Rotate engine crankshaft using engine barring method to align flywheel

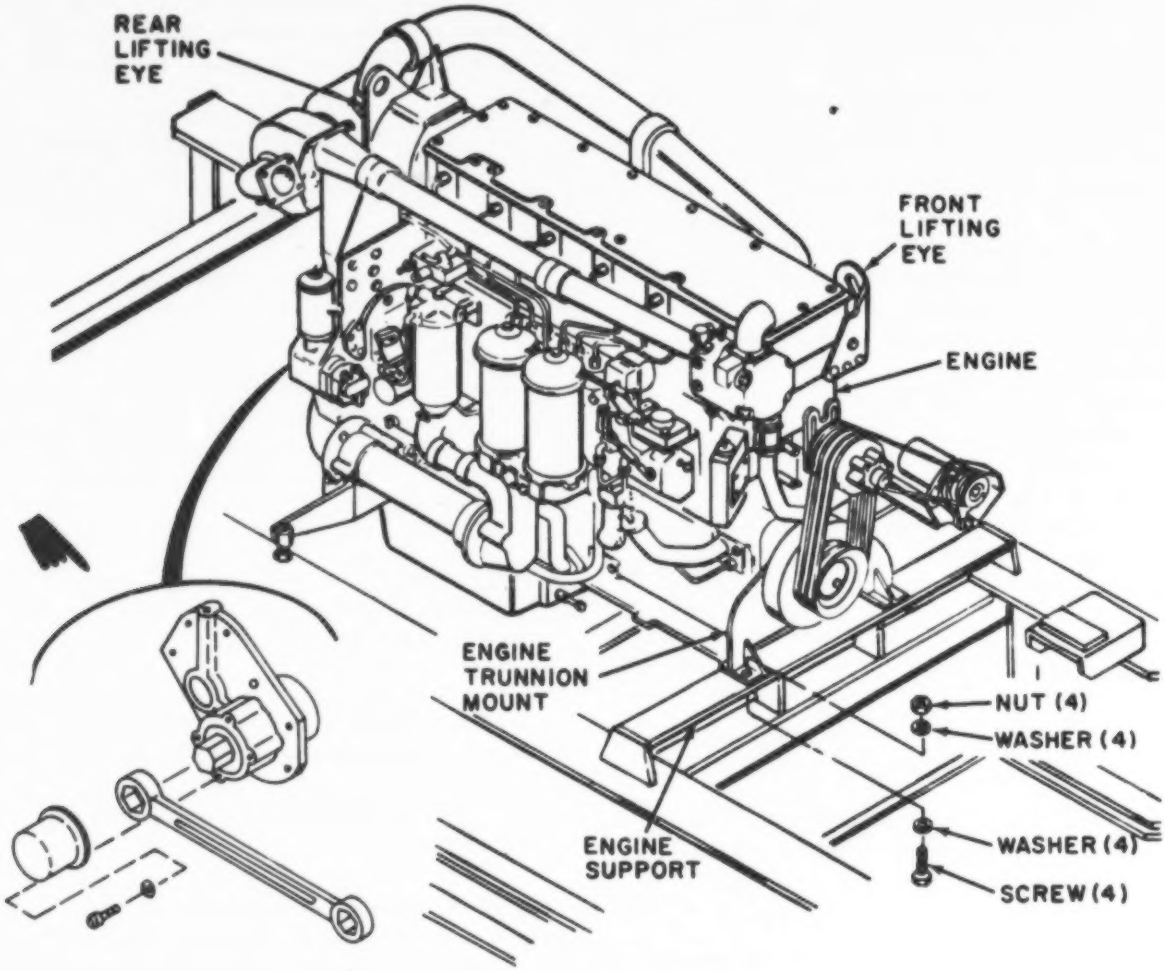
REAR LIFTING EYE
FRONT LIFTING EYE
ENGINE
ENGINE TRUNNION MOUNT
NUT (4)
WASHER (4)
ENGINE SUPPORT
WASHER (4)
SCREW (4)

Figure 2-6. Engine assembly, removal and installation

generator shaft coupling holes with holes in generator shaft couplings. After holes are aligned, push generator shaft couplings against engine flywheel, making sure couplings are inside of flywheel recess.

NOTE

Rotate engine crankshaft as required to gain access to screws.

10. Position generator fan on rear of shaft couplings and install locking plates (6, figure 2-5) and screws (5). Tighten screws evenly in a criss-cross pattern. Torque screws to 150 foot-pounds (20.745 kg meters). Bend corners of locking plates (6) against screws (5) to prevent screws from turning.

11. Install remaining screws (10) and washers (11). Tighten screws evenly and to 150 foot-pounds (20.745 kg meters) torque. Turn engine support bolts (16) so that bolts are clear of frame.

NOTE

Generator air gap should be 0.125 inch (3.175 mm).

12. Check generator air gap using a 0.125 inch(3.175 mm) feeler gage and feeler gage holder FB-312 (Manufactured by Snap-On Tools Corp. Kenosha, Wisconsin) or equivalent. Insert gauge through opening between generator frame and fan. Position gauge between main stator and main rotor, making sure gauge is positioned on high point of stator pole splices. Hold gauge stationary and rotate engine and generator approximately three revolutions by turning engine crankshaft. Measure clearance around main stator and main rotor at three equally spaced locations. There should be no evidence of interference. If interference is indicated, generator is defective or engine flywheel is not concentric.

12A. Turn engine support bolts until there is no contact with skidbase. Bolt should be at least $\frac{1}{4}$ inch (6.350mm) above skidbase.

13. Install screen (4) and secure with screws (3), washer (2), and nuts (1).

14. Using a suitable lifting device, position lifting frame on generator set skid base. Secure lifting frame to skid base with sixteen screws, washers, and nuts.

15. On precise generator sets, position governor control unit on lifting frame and secure with four screws, washers, and nuts. Connect electrical connectors to governor control unit and governor actuator. Connect harness to connector P8 on precise relay box. Secure harness to other harnesses with tie down strap.

16. Connect fuel filler hose to fuel tank and secure with clamp. Connect fuel tank vent hoses to fuel filler neck. Connect fuel hoses to fuel transfer valve, auxiliary fuel inlet fitting, fuel supply outlet fitting, day tank, and electric fuel transfer pump. Clamp hose to lifting frame.

17. Install stowage box on skid base and secure with three screws, washers, and nuts.

18. Connect engine block coolant drain hose to skid base fitting and secure with clamp.

19. Connect engine oil drain hose to engine oil drain valve.

20. Connect four upper side housing members to lifting frame and secure eight screws and washers. Connect two members to rear housing and secure with four screws and washers.

21. Refer to Operator and Organizational Maintenance Manual and perform the following:

(a) Connect three electrical leads to radio suppression diode assembly.

(b) Connect ether starting tube intake manifold.

(c) Connect engine harness to connector J5 of mode I relay box, connector J33 of day tank float valve, connector J38 of ether primer, connector J39 of DC control circuit breaker, and fuel tank fuel level send unit. Fasten harness to other harness with tiedown straps.

(d) If required, install winterization kit heaters and coolant lines. Connect kit harnesses to control boxes.

(e) Connect and adjust manual speed control.

(f) Install radiator and shutter assembly, fan, and fan guard.

(g) Install engine crankcase breather, crankcase breather hose assembly, muffler, and exhaust pipe.

(h) Install front and rear housing covers; engine, and generator compartment access doors. Connect muffler clamps to front housing cover.

(i) Connect starter ground cable to skid base. Connect cables to slave receptacles SR1 and SR2. Install negative battery cable.

(j) Service radiator, engine, and on precise generator sets hydraulic tank.

(k) Start engine and bleed fuel system and hydraulic system on precise generator sets.

# CHAPTER 3

## HOUSING AND LIFTING FRAME ASSEMBLY REPAIR INSTRUCTIONS

## Section I. HOUSING FRAME

### 3-1. GENERAL.

a. HOUSING FRAME. The housing frame reinforces the housing panels and doors. It provides interconnection between the lifting frame and front and rear housings.

b. FRONT HOUSING. The front housing is the mounting frame for the generator set radiator and shutter assembly. It also provides a connection point for the engine crankcase breather tube and slave receptacle SR2.

c. REAR HOUSING. The rear housing provides a mount for the control cubicle, fault locator panel, DC control cubicle, convenience receptacle, sleeve and plate assembly, parallel harness receptacles, manual speed control, and mounting openings for the controls of the generator set optional kits which are covered by plates if the kits are not installed. It also contains the air intake louver.

### 3-2. REMOVAL AND DISASSEMBLY.

Refer to figure 3-1 and remove and disassemble the housing frame in the order of index numbers assigned. Pay particular attention to the following:

a. Refer to Operator and Organizational Maintenance Manual and perform the following:

1. Disconnect negative battery cables.

2. Remove housing panels and doors.

3. Remove DC control circuit. breaker.

4. Disconnect parallel receptacle harness from rear housing.

5. Remove manual speed control.

6. Remove kit control panels from rear housing, if installed.

7. Remove slave receptacles from front housing.

8. Remove radiator and shutter assembly.

b. Remove control cubicle, as specified in paragraph 2-6.

c. Remove fault locator panel from rear housing by disconnecting harness from rear of locator panel and removing four screws attaching panel to rear housing.

d. Remove convenience receptacle assembly from rear housing by disconnecting harness from rear of assembly and removing six screws and washers securing assembly to rear housing.

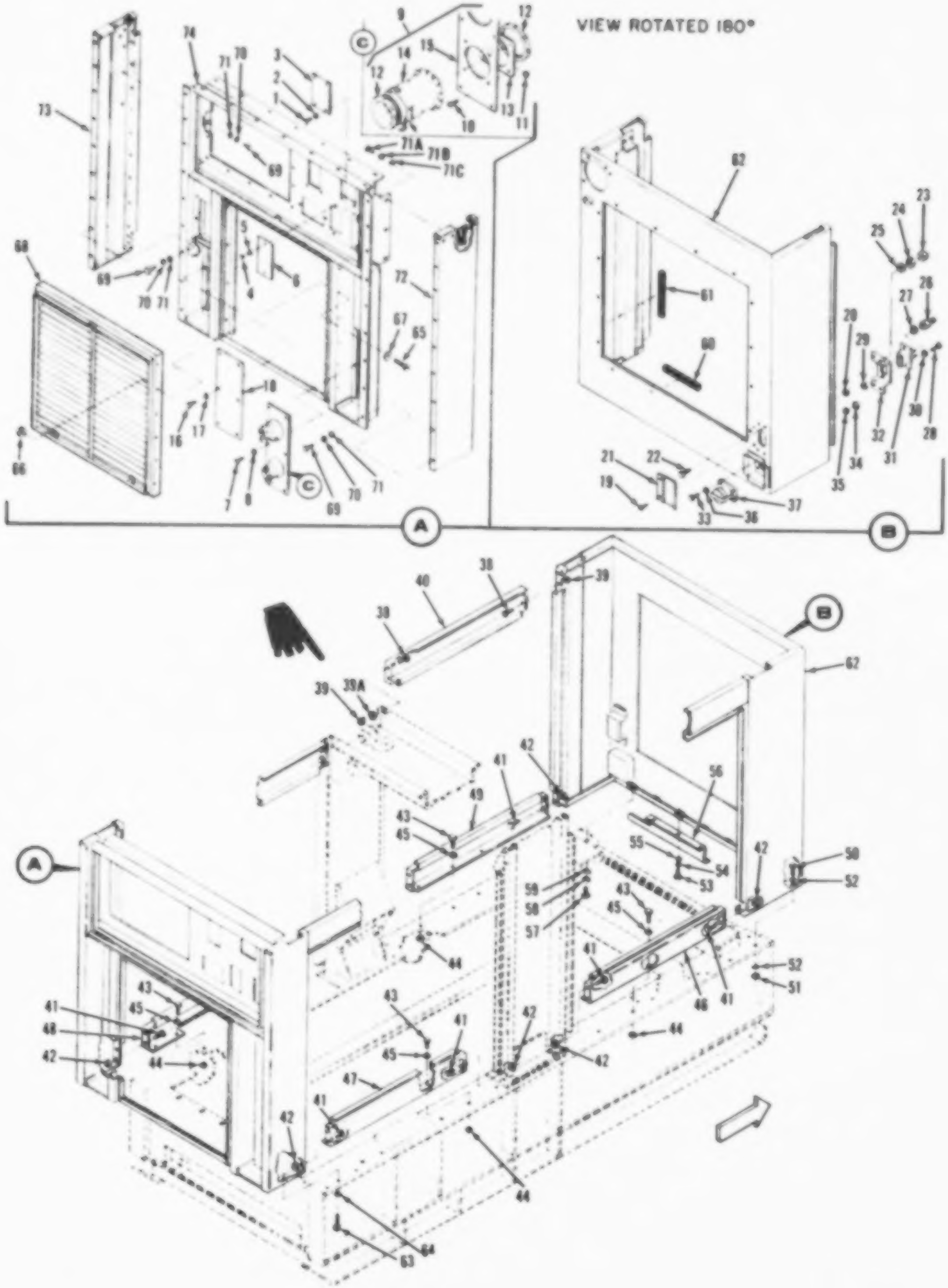
VIEW ROTATED 180°
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Figure 3-1. Housing frame, exploded view

Legend to figure 3-1:

1. Screw (4)
2. Lock washer (4)
3. Plate
4. Screw (4)
5. Lock washer (4)
6. Plate (2)
7. Screw (6)
8. Lock washer (6)
9. Plate and sleeve assy
10. Screw (8)
11. Nut and washer assembly (8)
12. Bushing (2)
13. Plate (2)
14. Sleeve (2)
15. Plate
16. Screw (6)
17. Lock washer (6)
18. Plate
19. Screw and washer assembly (2)
20. Nut and washer assy (2)
21. Connector cover
22. Screw (4)
23. Nut (4)
24. Lock washer (4)
25. Washer (4)
26. Stepped spacer
27. Lock washer
28. Screw and washer assembly (2)
29. Nut and washer assy (2)
30. Washer (2)
31. Receptacle
32. Bracket
33. Screw (4)
34. Nut (4)
35. Lock washer (4)
36. Washer (4)
37. Connector and lead
38. Screw (16)
39. Nut (16)

39A. Washer (16)

40. Upper housing side (4)
41. Screw (16)
42. Nut (16)
43. Screw (20)
44. Nut (20)
45. Washer (20)
46. Lower right housing side
47. Lower right housing side
48. Lower left housing side
49. Lower left housing side
50. Screw (6)
51. Nut (6)
52. Washer (12)
53. Screw (7)
54. Lock washer (7)
55. Washer (7)
56. Seal top frame
57. Screw (2)
58. Lock washer (2)
59. Washer (2)
60. Strip (2)
61. Strip (2)
62. Front housing
63. Screw (6)
64. Washer (6)
65. Screw (16)
66. Nut (16)
67. Washer (16)
68. Air intake louver
69. Screw
70. Lock washer

71A. Screw (6)
71B. Lock washer (6)
71C. Washer (6)

71. Washer
72. Right rear housing support
73. Left rear housing support
74. Rear housing

## 3-3. CLEANING.

a. Clean electrical components with a cloth moistened with an approved cleaning solvent, and dry thoroughly.

b. Clean metal components with an approved cleaning solvent, and dry thoroughly.

## 3-4. INSPECTION.

a. Inspect slave receptacles and leads for continuity and for shorts to casing.

b. Inspect terminal lugs for security and condition.

c. Inspect air intake louver screen for holes and tears.

d. Inspect components for dents, cracks, distortion.

e. Inspect threads for damage.

f. Inspect for damaged paint.

### 3-5. REPAIR.

a. Straighten dented and distorted sheet metal parts using suitable tools.

b. Remove damaged paint. Blend in edges, prime, and paint damaged areas.

### 3-6. REASSEMBLY AND INSTALLATION.

Refer to figure 3-1 and reassemble and install housing frame in the reverse order of index numbers assigned. Pay particular attention to the following:

NOTE

Wiring harness interconnecting diagram is contained in Operator and Organizational Maintenance Manual.

a. Install convenience receptacle assembly in rear housing and secure with six screws and washers. Connect harness to assembly.

b. Install fault locator panel in rear housing and secure with four screws. Connect harness to locator panel.

c. Install control cubicle, as specified in paragraph 2-6.

d. Refer to Operator and Organizational Maintenance Manual and perform the following:

1. Install radiator and shutter assembly.

2. Install slave receptacles in front housing.

3. If necessary, install kit control panels.

4. Install manual speed control.

5. Connect parallel receptacle harness in rear housing.

6. Install DC control circuit breaker.

7. Install housing panels and doors.

8. Connect negative battery cables.

## Section II. LIFTING FRAME ASSEMBLY

### 3-7. GENERAL.

The lifting frame assembly is bolted to the skid base and provides the means of lifting the generator set. Two clevis are located at the top of the lifting frame to permit attachment of a suitable lifting device. The lifting frame is the center support for the housing assembly. Bolted to the lifting frame are the day tank, fuel transfer valve, fuel tank filler neck and tube, and manual speed control bracket.

### 3-8. REMOVAL.

Refer to figure 3-2 and remove lifting frame as follows:

a. Remove housing frame as specified in paragraph 3-2.

b. Disconnect fuel hoses from lifting frame by removing screw, nut, and clamp.

c. Refer to Operator and Organizational Maintenance Manual and perform the following:

1. Remove fuel transfer valve, fuel inlet fitting, and fuel supply outlet fitting.

2. Remove day tank.

3. Disconnect manual speed control bracket from lifting frame.

4. Remove air cleaner.

d. Loosen clamp (1) securing hose (12) to fuel tank and remove hose from tank. Plug tank opening. Remove fuel lines connected to filler neck.

e. Disconnect electrical connectors from governor control unit (34) and lift governor control unit (34) from retainer (41). Remove guard (33) by removing screws (32).

f. Remove nuts (2 and 6), screws (4 and 8), and washers (3, 5, 7, and 9). Connect an overhead lifting device to clevis (31) and remove lifting frame (10) from skid base. Guide lifting frame during lifting operation to prevent damage to components.

## 3-9. DISASSEMBLY.

Refer to figure 3-2 and disassemble lifting frame as follows:

a. Loosen clamp (11) and remove hose (12).

b. Remove fuel filler cap (13), pull cap chain and remove filler tube (14) and cap from filler neck (17).

c. Remove nuts (15), screws (16), filler neck (17), and gasket (18) from lifting frame.

d. Remove nuts (19, 22, and 25), screws (20, 23, and 26), and plates (21, 24, and 27).

e. Remove cotter pins (28), nuts (29), screws (30), and clevis (31).

f. Remove retainer (41) and bracket (44) from lifting frame by removing screws (38 and 42), nuts (39 and 43), and washers (40). Remove bracket (44) from retainer (41) by removing screws (35), nuts (36), and washers (37).

## 3-10. CLEANING.

a. Clean old gasket from lifting frame and filler neck using a suitable scraper.

b. Clean parts with an approved cleaning solvent, and dry thoroughly.

## 3-11. INSPECTION.

a. Inspect for damaged threads.

b. Inspect parts for cracks, breaks, and defective welds.

c. Inspect hose for cuts, tears, and deterioration.

d. Inspect filler tube screen for holes, cuts, and other damage.

e. Inspect lifting frame mounting screw holes for elongation.

f. Inspect plates for legibility.

g. Inspect paint for damage.

## 3-12. REPAIR.

a. Repair cracks by welding.

b. Remove damaged paint. Blend in edges, prime, and paint damaged areas.

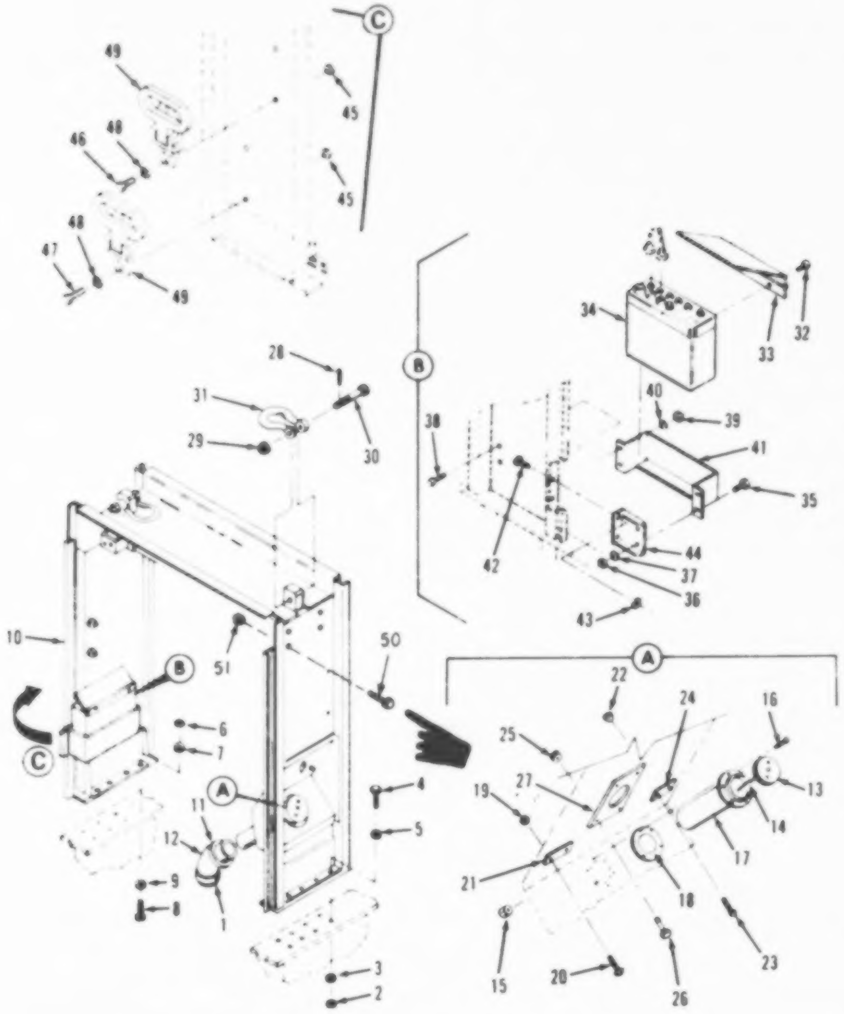
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Figure 3-2. Lifting frame assembly, exploded view

## 3-13. REASSEMBLY.

Refer to figure 3-2 and reassemble lifting frame as follows:

a. Assemble bracket (44) to retainer (41) and secure with screws (35), nuts (36), and washers (37). Position retainer (41) and bracket (44) to lifting frame and secure with screws (38 and 42), nuts (39 and 43), and washers (40).

b. Install clevis (31), screws (30), and nuts (29). Tighten nuts (29) so that clevis are just free to move and cotter pin holes in nuts and screws are aligned. Install cotter pins (28).

c. Position plates (21, 24, and 27) on lifting frame (10) and secure with screws (20, 23, and 26) and nuts (19, 22, and 25).

Legend to figure 3-2:

1. Clamp
2. Nut (8)
3. Washer (8)
4. Screw (8)
5. Washer (8)
6. Nut (8)
7. Washer (8)
8. Screw (8)
9. Washer (8)
10. Lifting frame
11. Clamp
12. Hose
13. Fuel filler cap and chain
14. Filler tube and screen
15. Nut (6)
16. Screw (6)
17. Filler neck
18. Gasket
19. Nut (2)
20. Screw (2)
21. Fuel inlet plate
22. Nut (2)
23. Screw (2)
24. Fuel outlet plate
25. Nut (2)
26. Screw (2)
27. Fuel selector plate
28. Cotter pin (2)
29. Nut (2)
30. Screw (2)
31. Clevis (2)
32. Screw (2)
33. Guard
34. Governor control unit
35. Screw (2)
36. Nut (2)
37. Washer (2)
38. Screw (2)
39. Nut (2)
40. Washer (2)
41. Retainer
42. Screw (2)
43. Nut (2)
44. Bracket
45. Nut (4)
46. Screw (2)
47. Screw (2)
48. Washer (4)
49. Step (2)
50. Bolts (8)
51. Nut (8)

d. Position gasket (18) and filler neck (17) in lifting frame (10) and secure with screws (16) and nuts (15). Install filler tube (14) and cap (13).

e. Position hose (12) on filler neck and secure with clamp (11).

## 3-14. INSTALLATION.

Refer to figure 3-2 and install lifting frame as follows:

a. Connect an overhead lifting device to clevis (31) and carefully position lifting frame (10) on skid base. Secure lifting frame to skid base with screws (4 and 8), washers (3, 5, 7, and 9), and nuts (2 and 6).

b. Position hose (12) on fuel tank and secure hose with clamp (1).

c. Secure guard (33) to governor control unit with screws (32). Place governor control unit into retainer (41) and connect electrical connectors.

d. Refer to Operator and Organizational Maintenance Manual and perform the following:

1. Install air cleaner.
2. Connect and adjust manual speed control bracket on lifting frame.
3. Install fuel transfer valve, fuel inlet fitting, and fuel supply outlet fitting.
4. Install day tank.

e. Secure fuel hoses to lifting frame with clamp, screw, and nut.

f. Install housing frame as specified in paragraph 3-6.

# CHAPTER 4

# RADIATOR AND SHUTTER ASSEMBLY REPAIR INSTRUCTIONS

## Section I. RADIATOR ASSEMBLY

4-1. GENERAL.

The radiator assembly consists of top and bottom tanks, core assembly, vent tube, mounting brackets, shroud, and orifice plate. The shroud and orifice plate are bolted to the radiator and insure that air drawn by the fan is forced through the radiator when exiting the generator set. The upper tank and mounting brackets are bolted to the core assembly, the brackets provide a means of mounting the radiator and the tank provides area for storage of coolant. The vent tube permits overflowing coolant to leave the radiator. Refer to Appendix A for applicable technical manual for additional information pertaining to radiator.

4-2. SHROUD AND ORIFICE PLATE.

4-3. REMOVAL. Refer to Operator and Organizational Maintenance Manual and remove shroud and orifice plate.

4-4. CLEANING. Clean parts with an approved cleaning solvent and dry thoroughly.

4-5. INSPECTION. Inspect shroud and orifice plate for cracks and distortion.

4-6. REPAIR. Repair cracks by welding and straighten distorted parts using proper tools.

4-7. INSTALLATION. Refer to Operator and Organizational Maintenance Manual and install shroud and orifice plate.

4-8. RADIATOR.

4-9. REMOVAL. Refer to Operator and Organizational Maintenance Manual and remove the radiator.

4-10. TEST.

a. Differential Pressure Test.

1. Plug shutter power element port on bottom radiator tank. Check that vent tube is free of obstructions by forcing compressed air through tube. Install radiator cap.

2: Connect a suitable water supply to lower radiator hose tube and reverse flush radiator until water flowing from upper radiator hose tube is clear.

3. Connect water supply to upper radiator hose tube and flush radiator until water flowing from lower tube is clear.

NOTE

All test equipment must have a minimum inside diameter of 2.5 inches.

4. Connect 0 to 20 PSI (0 to 1.406 kg/sq cm) pressure gauges to radiator hose tubes. Connect manual shut off valve and then a 190 GPM (719.15 LPM) water supply to upper radiator hose tube. Connect return line from gauge at lower radiator hose tube to water supply reservoir. Close manual shutoff valve.

CAUTION

Stop test immediately if pressure gauge at top hose port reaches 15 PSI (1.054 kg/sq cm).

5. Start water supply. Slowly open manual shutoff valve while observing gauge at top hose tube. Stop test if pressure reaches 15 PSI (1.054 kg/sq cm). Fully open shutoff valve and record pressure on both gauges. If pressure differential between upper and lower gauges exceeds 2.2 PSI (.154 kg/sq cm), the radiator is restricted.

6. Shut down water supply, relieve pressure, and remove test equipment from radiator. If pressure differential exceeded 2.2 PSI (.154 kg/sq cm), remove radiator cap and perform the following procedures.

CAUTION

Do not immerse cold radiator in boiling solution.

7. Mix a solution of one pound baking soda to each gallon of water. Fill a suitable boiling tank with solution and place radiator in tank. Bring solution to a boil and boil radiator for a minimum of 30 minutes. Remove radiator and perform steps 2. through 6.

8. If pressure differential still exceeds 2.2 PSI (.154 kg/sq cm), the radiator must be disassembled and cleaned.

b. Pressure Test.

1. Plug radiator filler neck, hose tubes, and shutter power element port. Connect a regulated pressure air supply manual shutoff valve, and 0-20 PSI (0 to 1.406 kg/sq cm) pressure gauge, to radiator vent tube.

2. Place radiator in suitable tank filled with water.

3. Slowly apply 15 PSI (1.054 kg/sq cm) to radiator and check for air bubbles that would indicate leaks. Mark leaks if any.

4. Remove radiator from tank. Relieve all air pressure and remove test equipment. Repair leaks.

4-11. DISASSEMBLY. Refer to figure 4-1 and disassemble radiator as follows:

NOTE

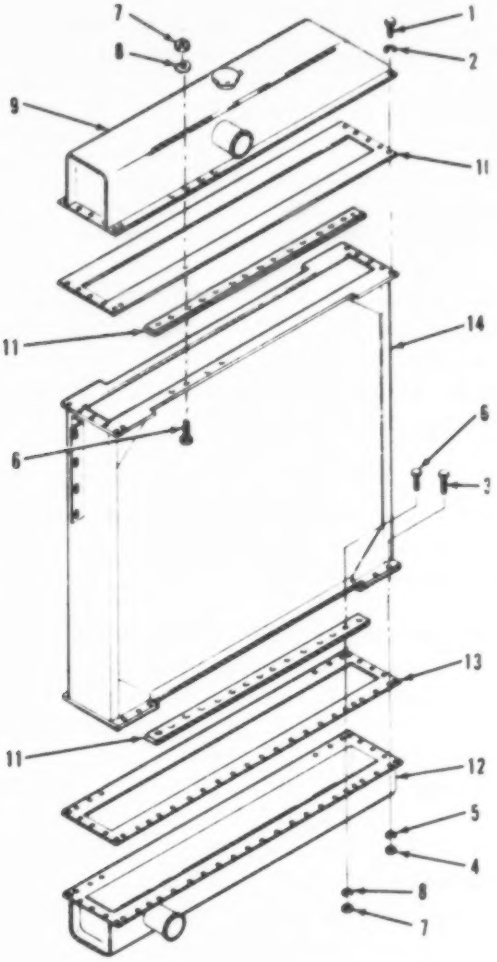
Prior to disassembly of radiator, its condition should be analyzed by performing test specified in paragraph 4-10.

a. Mark mounting brackets, top tank and bottom tank in relation to core assembly to insure proper reassembly.

NOTE

Exercise care when removing upper and lower tanks to preclude damage to the gaskets (8).

b. Remove bolts (1, 3, and 6), nuts (4 and 7), lock washers (5 and 8), and boiling strips (11). Remove upper tank (9), lower tank (12), and gaskets (10 and 13).



1. BOLT (20)
2. LOCKWASHER (20)
3. BOLT (24)
4. NUT (24)
5. LOCKWASHER (24)
6. BOLT (60)
7. NUT (60)
8. LOCKWASHER (60)
9. UPPER TANK
10. GASKET
11. BOLTING STRIP (4)
12. LOWER TANK
13. GASKET
14. RADIATOR CORE

Figure 4-1. Radiator assembly, exploded view

## 4-12. CLEANING.

a. Remove obstruction from radiator core fins using compressed air.

b. If core assembly tubes are clogged, boil core assembly in a solution of one pound of baking soda to each gallon of water for a minimum of 30 minutes or until clog is loosened.

c. Clean core assembly tubes using a suitable bristle brush or cleaning rod. Remove loosened particles using compressed air.

d. Clean parts with an approved cleaning solvent and dry thoroughly.

## 4-13. INSPECTION.

a. Test radiator cap using suitable cap tester. Cap setting should be approximately 7 PSI (.492 kg/sq cm). Check locking tabs for condition.

b. Inspect mounting brackets for cracks or distortion.

c. Inspect tanks for cracks, holes, or dents. Check hose connection tubes for out-of-roundness, security, and damage. Check filler neck for damage and security. Check bottom tank flange for security, damaged threads, and damage to gasket contact surface.

d. Inspect core assembly for loose tubes, bent or damaged cooling fins, and damage to tank contact surfaces.

e. Inspect paint for damage.

## 4-14. REPAIR.

a. Repair cracks in mounting brackets by welding. Straighten distorted parts using proper tools.

b. Weld cracks and holes in tanks. Large holes or cracks may be repaired by welding a suitable patch over defect. Weld loose hose connection tubes, filler neck, or bottom tank flange. Remove burrs from flange using suitable file or stone.

c. Weld loose core assembly tubes. To repair damaged tubes, remove cooling fins in area of leak and weld leak. Weld cooling fin back into position. To replace a defective tube, unsolder tube from core assembly and remove tube. Insert a suitable replacement tube in core assembly and solder in position. Straighten bent cooling fins.

d. Remove damaged paint using a suitable scraper. Blend in edges, prime, and paint damaged areas.

4-15. REASSEMBLY. Refer to figure 4-1 and reassemble radiator as follows:

NOTE

If new gaskets (10 and 13) are required, fabricate from Vellumoid No. 444 or equivalent.

a. Place gasket (10) and upper tank (9) on core assembly (14). Secure with bolting strips (11), bolts (1, 3, and 6), nuts (4 and 7), and lockwashers (5 and 8). Repeat procedure for lower tank (12).

b. Test radiator as specified in paragraph 4-10. Perform necessary procedures if radiator does not meet required test results.

4-16. INSTALLATION. Refer to Operator and Organizational Maintenance Manual and install radiator.

## Section II. SHUTTER AND CONTROL ASSEMBLY

### 4-17. GENERAL.

The shutter consists of movable vanes mounted in nylon bearings which are actuated by a control rod connected to the control assembly. When engine coolant temperature reaches 158°F (70°C), the control assembly power element starts to extend which moves the control rod opening the shutter vanes. If coolant temperature decreases, the control assembly integral return spring moves the control rod closing the shutter vanes. The modulated control automatically opens and closes the shutter vanes the amount necessary to maintain the engine at normal operating temperature. Opening and closing of the shutter vanes regulates cooling air flow through the radiator. The shutter assembly is equipped with a manual control handle to permit manual opening of the shutter vanes. The handle should be in the full up position during normal operation.

### 4-18. CONTROL ASSEMBLY.

4-19. REMOVAL. Refer to Operator and Organizational Maintenance Manual and remove the control assembly.

4-20. DISASSEMBLY. Refer to figure 4-2 and disassemble the control assembly in

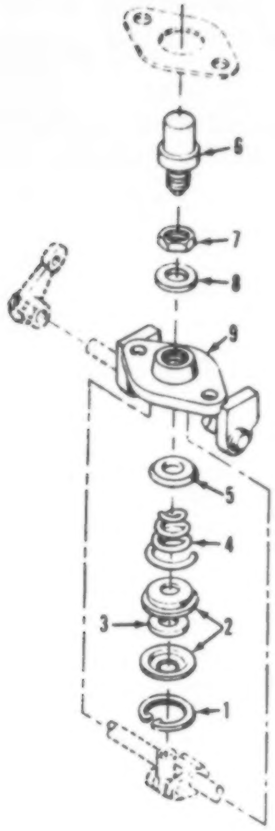


Figure 4-2. Shutter control assembly, exploded view

Legend to figure 4-2:

1. Retaining ring
2. Large seat (2)
3. Felt washer
4. Spring
5. Small seat
6. Power element
7. Nut
8. Preformed packing
9. Flange

the order of index numbers assigned. Pay particular attention to the following:

a. When removing retaining ring (1), press in on large seat (2) to relieve spring tension on ring. Remove retaining ring and slowly remove large seat until spring tension is relieved.

4-21. CLEANING. Clean parts in an approved cleaning solvent and dry thoroughly.

4-22. INSPECTION.

a. Inspect threads for damage and parts for cracks.

b. Inspect shaft for nicks, burrs, and scoring in flange bushing area.

c. Inspect flange bushing for nicks, scores, and out of roundness.

d. Inspect springs for distortion and broken ends.

e. Test power element for proper operation, refer to Operator and Organizational Maintenance Manual.

4-23. REPAIR.

a. Remove nicks and burrs using a file or stone.

4-24. REASSEMBLY. Refer to figure 4-2 and reassemble the control assembly in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Apply a thin film of oil to packing (8). Position nut (7) and packing (8) on flange (9). Screw power element (6) into flange (9) until top of power element is 3.0 inches above flat of flange. Hold power element stationary and tighten nut (7).

4-25. INSTALLATION. Refer to Operator and Organizational Maintenance Manual and install control assembly.

## 4-26. SHUTTER.

4-27. REMOVAL. Refer to Operator and Organizational Maintenance Manual and remove shutter.

4-28. DISASSEMBLY. Refer to figure 4-3 and disassemble the shutter in the order of index numbers assigned. Pay particular attention to the following:

a. To remove bushings (7), remove spring clips (6). Remove channels (8) and (10) to remove vanes (9).

NOTE

All vanes do not have spring clips (6) installed.

## 4-29. CLEANING.

a. Clean parts in an approved cleaning solvent and dry thoroughly.

b. If shutter is not to be fully disassembled, clean shutter vane bushing using compressed air.

## 4-30. INSPECTION.

a. Inspect threads for damage.

b. Inspect control rod assembly for distortion and missing components.

c. Inspect springs for distortion and broken ends.

d. Inspect bushings for out-of-roundness, cuts, and cracks.

e. Inspect channels for distortion and for elongated holes.

f. Inspect vanes for cracks and nicks, burrs, and grooves on bushing contact surfaces.

## 4-31. REPAIR.

a. Straighten distorted parts using suitable tools.

b. Remove nicks or burrs from vane bushing contact surfaces using a file or stone.

4-32. REASSEMBLY. Refer to figure 4-3 and reassemble the shutter in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Make sure bushings and vanes are free of oil and grease prior to reassembly to prevent collection of dirt and dust.

b. After reassembly, open shutter using control rod and check that spring will close vanes.

4-33. INSTALLATION. Refer to Operator and Organizational maintenance manual and install shutter.

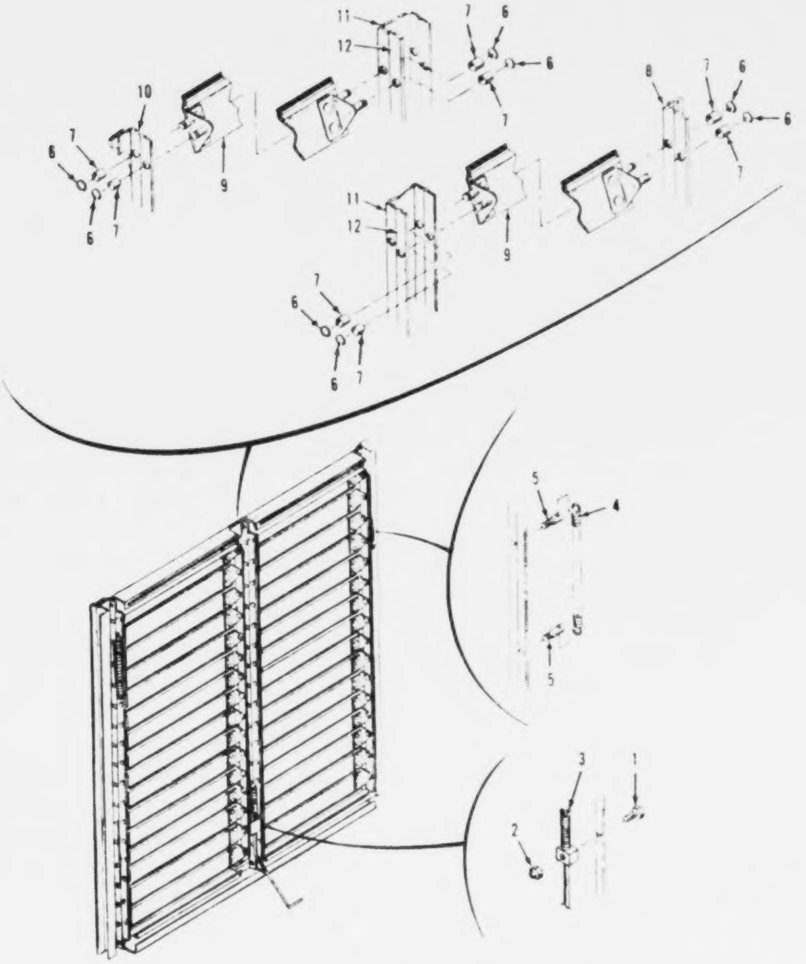

11
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Figure 4-3. Shutter, exploded view

Legend to figure 4-3:

1. Bolt
2. Locknut
3. Control rod assembly
4. Spring (2)
5. Stud (4)
6. Spring clip (76)
7. Nylon bushing (152)
8. Channel
9. Vane (38)
10. Channel
11. Stationary channel
12. Moveable channel

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# CHAPTER 5

# ELECTRICAL CONTROLS WIRING HARNESSES REPAIR INSTRUCTIONS

## 5-1. GENERAL.

The electrical controls wiring harnesses interconnect the electrical components of the generator set.

a. Relay Box to Control Cubicle Harness. The harness is connected to connector J1 of the control cubicle (A3) and connector J2 of the mode I relay box (A27).

b. Relay Box To Exciter Regulator Harness. The harness is connected to connector J9 of the exciter regulator (A10 and A11) and connector J3 of the mode I relay box (A27).

c. Tactical Relay Box To Load Measurement Unit Harness. The harness is connected to connector J4 of the tactical relay box (A7) and connector J16 of the load measurement unit (A8).

d. Relay Box To Precise Relay Box Harness. The harness is connected to connector J32 of the precise relay box (A25) and connector J31 of the mode I relay box (A27).

e. Relay Box To Governor Control Unit Harness. The harness is connected to connectors J21 and J17 of the governor control unit (A23) and connector J8 of the precise relay box (A25) on 50/60 hertz precise generator sets. The harness is not used on utility generator sets.

f. Governor Control Unit To Governor Actuator Harness. The harness is connected to connectors J22 and J23 of the governor control unit (A23) and connectors J24 and J25 of the governor actuator (A24). The harness is not used on utility generator sets.

g. Relay Box to Reconnection Board Harness. The harness is connected to connector J10 of the mode I relay box (A27), connector J13 of the exciter regulator (A10 and A11), connector J41 of the circuit breaker (CB2), connector J48 of the convenience receptacle (A22), connector J61 of generator (G1), and to terminals of the load board and terminal boards (TB2 and TB6).

h. Relay Box To Fault Locator Indicator Harness. The harness is connected to connector J12 of the fault locator indicator (A9) and to connector J6 of the mode I relay box (A27).

i. Parallel Receptacle Harness. The harness is connected to connector J15 of the mode I relay box (A27). The three connectors of the harness J45, J46, and J47 are the parallel receptacles located at the rear of the generator set.

j. Relay Box to Tactical Relay Box Harness. The harness is connected to connector J51 of the tactical relay box (A7) and connector J50 of the mode I relay box (A27).

k. Starter Motor to Slave Receptacle Electrical Lead. This electrical lead is connected to negative terminal of starter motor B1 and to the negative terminal of slave receptacle SR-2.

l. Starter Solenoid to Slave Receptacle Electrical Lead. This electrical lead is connected to starter solenoid L4 and to the positive terminal of slave receptacle SR-2.

m. Starter Motor to Ground Electrical Lead. This electrical lead is the ground lead connected to negative terminal of starter motor B1 and the frame. It is secured to the frame by a screw, two washers and a nut.

n. Slave Receptacle to Battery Terminal Block Positive Electrical Lead. This electrical lead is connected to the positive terminal of slave receptacle SR-2 and the positive terminal of the battery terminal block TB-1.

o. Slave Receptacle to Battery Terminal Block Negative Electrical Lead. This electrical lead is connected to the negative terminal of slave receptacle SR-2 and the negative terminal of the battery terminal block TB1.

p. Circuit Breaker and Load Board Electrical Leads. These electrical leads are of the same construction differing only in length and lug position. They are connected to the following terminals.

TB6-13 to L0-A
TB6-13 to L0-B
CB2-A2 to L1-A
CB2-A2 to L1-B
CB2-B2 to L2-A
CB2-B2 to L2-B
CB2-C2 to L3-B
CB2-C2 to L3-A
CB2-A1 to TB6-1
CB2-A1 to TB6-1
CB2-B1 to TB6-2
CB2-B1 to TB6-2
CB2-C1 to TB6-3
CB2-C1 to TB6-3

## 5-2. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove the wiring harness and electrical leads.

## 5-3. CLEANING.

a. Clean connector pins with low pressure, filtered compressed air.

b. Clean connectors and terminal lugs with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

c. Remove oil and grease from wires using a clean lint-free cloth.

## 5-4. INSPECTION.

a. Inspect connectors for loose, bent, and damaged pins; damaged threads; and defective keys.

b. Check terminal lugs for security and condition.

c. Inspect harness wires for defective insulation, illegible wire numbers. Check harness straps for condition, security, and proper spacing.

NOTE

Interconnecting wiring diagram is contained in the Operator and Organizational Maintenance Manual.

d. Check each harness wire for continuity from connector pin to wire end. Check connector pins for shorts to case and surrounding pins. Check electrical leads for continuity. Refer to figures 5-1 through 5-16.

## 5-5. REBUILD.

a. Refer to figure 5-1 and rebuild relay box to control cubicle harness.

b. Refer to figure 5-2 and rebuild relay box to exciter regulator harness.

c. Refer to figure 5-3 and rebuild tactical relay box to load measurement unit harness.

d. Refer to figure 5-4 and rebuild relay box to precise relay box harness on precise generator sets.

e. Refer to figure 5-5 and rebuild relay box to governor control unit harness on precise generator sets.

f. Refer to figure 5-6 and rebuild governor control unit to governor actuator harness on precise generator sets.

g. Refer to figure 5-7 and rebuild relay box to reconnection board harness.

h. Refer to figure 5-8 and rebuild relay box to fault locator indicator harness.

i. Refer to figure 5-9 and rebuild parallel receptacle harness.

j. Refer to figure 5-10 and rebuild relay box to tactical realy box harness.

k. Refer to figure 5-11 and fabricate new starter motor to slave receptacle electrical lead.

l. Refer to figure 5-12 and fabricate new starter solenoid to slave receptacle electrical lead.

m. Refer to figure 5-13 and fabricate new starter motor to ground electrical lead.

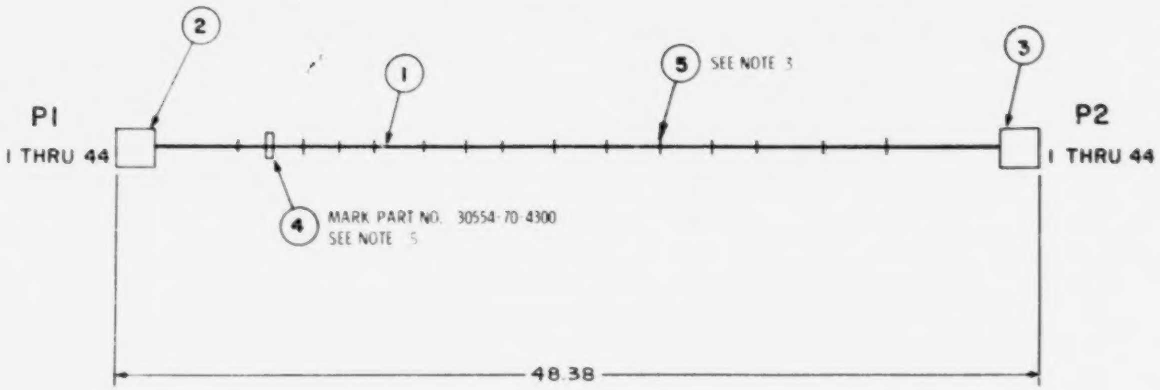
n. Refer to figure 5-14 and fabricate new slave receptacle to battery terminal block positive electrical lead.

o. Refer to figure 5-15 and fabricate new slave receptacle to battery terminal block negative electrical lead.

p. Refer to figure 5-16 and fabricate new circuit breaker and load board electrical leads.

## 5-6. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install the wiring harnesses and electrical leads.



| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 6 | | | SN60WARP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 5 | | | MS3367-1-9 | 14 | STRAP, TIEDOWN | | NYLON |
| 4 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 3 | | | MS3106R36-7P | 1 | CONNECTOR, PLUG | | |
| 2 | | | MS3106R36-7S | 1 | CONNECTOR, PLUG | | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |

NOTES:

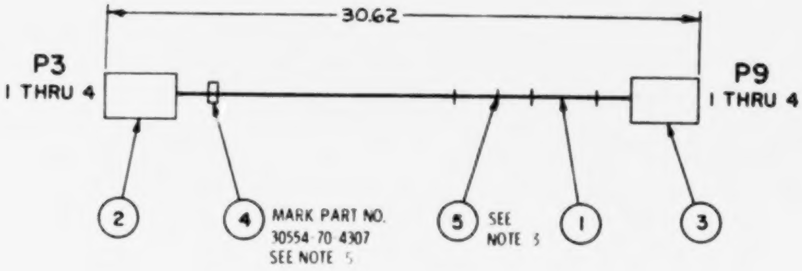
1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6
3. CABLE STRAPS, FIND NO. 5 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

Figure 5-1. Relay box to control cubicle wire harness
(sheet 1 of 2)

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | D20C16 | P1-A | 2 | P2-A | 3 | 46.00 |
| 2 | BLACK | D21C16 | P1-B | ↑ | P2-B | ↑ | 46.00 |
| 3 | BLACK | D22C16 | P1-C | | P2-C | | 46.00 |
| 4 | BLACK | D24C16 | P1-D | | P2-D | | 46.00 |
| 5 | BLACK | X7C16 | P1-E | | P2-E | | 46.00 |
| 6 | BLACK | X8C16 | P1-F | | P2-F | | 46.00 |
| 7 | BLACK | X14C16 | P1-G | | P2-G | | 46.00 |
| 8 | BLACK | X15C16 | P1-H | | P2-H | | 46.00 |
| 9 | BLACK | X16C16 | P1-I | | P2-I | | 46.00 |
| 10 | BLACK | L25B16 | P1-J | | P2-J | | 46.00 |
| 11 | BLACK | L26B16 | P1-K | | P2-K | | 46.00 |
| 12 | BLACK | X91B16 | P1-L | | P2-L | | 46.00 |
| 13 | BLACK | K32B16 | P1-M | | P2-M | | 46.00 |
| 14 | BLACK | K33B16 | P1-N | | P2-N | | 46.00 |
| 15 | BLACK | X31B16 | P1-O | | P2-O | | 46.00 |
| 16 | BLACK | X194B16 | P1-P | | P2-P | | 46.00 |
| 17 | RED | P45F16 | P1-R | | P2-R | | 46.00 |
| 18 | BLACK | X29B16 | P1-S | | P2-S | | 46.00 |
| 19 | BLACK | K34B16 | P1-T | | P2-T | | 46.00 |
| 20 | BLACK | X90C16 | P1-U | | P2-U | | 46.00 |
| 21 | RED | E39B16 | P1-V | | P2-V | | 46.00 |
| 22 | RED | E38B16 | P1-W | | P2-W | | 46.00 |
| 23 | RED | E37B16 | P1-X | | P2-X | | 46.00 |
| 24 | RED | E35B16 | P1-Y | | P2-Y | | 46.00 |
| 25 | RED | E36B16 | P1-Z | | P2-Z | | 46.00 |
| 26 | RED | P199B16 | P1-a | | P2-a | | 46.00 |
| 27 | BLACK | L93C16 | P1-b | | P2-b | | 46.00 |
| 28 | RED | P198B16 | P1-c | | P2-c | | 46.00 |
| 29 | RED | P47C16 | P1-e | | P2-e | | 46.00 |
| 30 | BLACK | X195B16 | P1-f | | P2-f | | 46.00 |
| 31 | RED | P44C16 | P1-g | | P2-g | | 46.00 |
| 32 | RED | P62C16 | P1-h | | P2-h | | 46.00 |
| 33 | RED | P56C16 | P1-k | | P2-k | | 46.00 |
| 34 | RED | P80D16 | P1-m | | P2-m | | 46.00 |
| 35 | BLACK | X197B16 | P1-n | | P2-n | | 46.00 |
| 36 | RED | P55LL16 | P1-p | | P2-p | | 46.00 |
| 37 | RED | P55X16 | P1-r | | P2-r | | 46.00 |
| 38 | RED | P57016 | P1-t | | P2-t | | 46.00 |
| 39 | RED | P40M16 | P1-u | | P2-u | | 46.00 |
| 40 | RED | P40L16 | P1-v | | P2-v | | 46.00 |
| 41 | RED | P50J16 | P1-w | | P2-w | | 46.00 |
| 42 | RED | P46B16 | P1-x | | P2-x | | 46.00 |
| 43 | BLACK | X12C16 | P1-y | ↓ | P2-y | ↓ | 46.00 |
| 44 | BLACK | X9C16 | P1-z | 2 | P2-z | 3 | 46.00 |

Figure 5-1. Relay box to control cubicle wire harness (sheet 2 of 2)



| WIRE NO. | WIRE MARKING IDENTIFICATION |  | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
|  | COLOR | NUMBER |  |  |  |  |  |
| 1 | BLACK | X91D16 | P3-A | 2 | P9-A | 3 | 29.75 |
| 2 | BLACK | X197F16 | P3-B | ↑ | P9-B | ↑ | 29.75 |
| 3 | RED | P42B16 | P3-C | ↓ | P9-C | ↓ | 29.75 |
| 4 | RED | P67B16 | P3-D | 2 | P9-D | 3 | 29.75 |

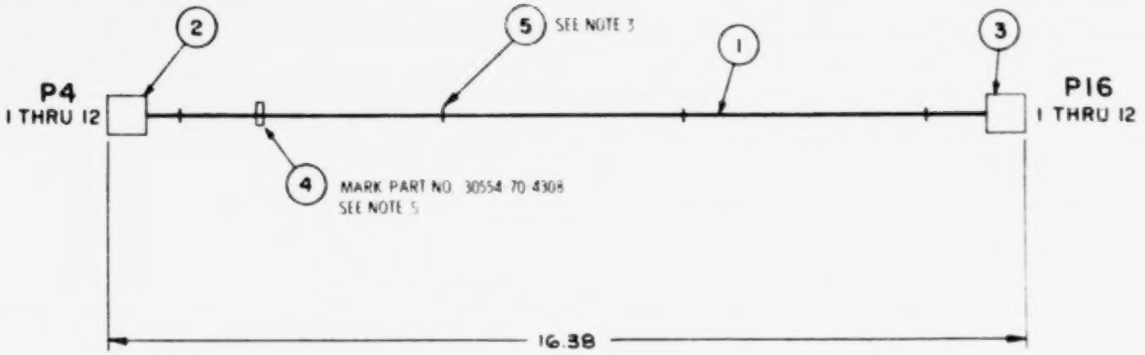
| WIRE LENGTH TOLERANCES |  |  |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 6 |  |  | SN60WRAP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 5 |  |  | MS3367-4-9 | 8 | STRAP, TIEDOWN |  | NYLON |
| 4 |  |  | MS39020-2 | 1 | BAND, MARKER |  | AL ALY |
| 3 |  |  | MS3106R14S-6S | 1 | CONNECTOR, PLUG |  |  |
| 2 |  |  | MS3106R14S-6P | 1 | CONNECTOR, PLUG |  |  |
| 1 |  |  | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 |  |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6
3. CABLE STRAPS, FIND NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 5-2. Relay box to exciter regulator wire harness



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | | | SN60WRAP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 5 | | | MS3367-1-9 | 4 | STRAP, TIEDOWN | | NYLON |
| 4 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 3 | | | MS3108R20-29S | 1 | CONNECTOR, PLUG, ANGLE | | |
| 2 | | | MS3106R20-29S | 1 | CONNECTOR, PLUG | | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |

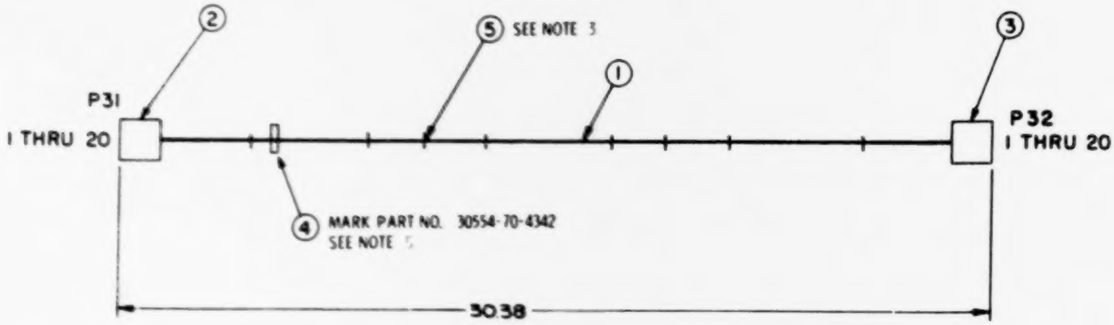
| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | X7L16 | P4-A | 2 | P16-A | 3 | 14.00 |
| 2 | BLACK | X8L16 | P4-B | ↑ | P16-B | ↑ | 14.00 |
| 3 | BLACK | X9Z16 | P4-C | | P16-C | | 14.00 |
| 4 | BLACK | X115A16 | P4-D | | P16-D | | 14.00 |
| 5 | BLACK | X116A16 | P4-E | | P16-E | | 14.00 |
| 6 | BLACK | X117A16 | P4-F | | P16-F | | 14.00 |
| 7 | BLACK | D24K16 | P4-G | | P16-G | | 14.00 |
| 8 | BLACK | X12JJ16 | P4-K | | P16-K | | 14.00 |
| 9 | BLACK | X12LL16 | P4-L | | P16-L | | 14.00 |
| 10 | BLACK | X12EE16 | P4-M | | P16-M | | 14.00 |
| 11 | BLACK | K101A16 | P4-N | ↓ | P16-N | ↓ | 14.00 |
| 12 | BLACK | K102A16 | P4-S | 2 | P16-S | 3 | 14.00 |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6 .
3. CABLE STRAPS, FIND NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 5-3. Tactical relay box to load measuring unit wire harness



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | | | SN60WRAP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN GEAR | QQ-S-571 | NOTE 2 |
| 5 | | | MS3367-1-9 | 8 | STRAP, TIEDOWN | | NYLON |
| 4 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 3 | | | MS3106R24-28S | 1 | CONNECTOR, PLUG | | |
| 2 | | | MS3106R24-28P | 1 | CONNECTOR, PLUG | | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | X9L16 | P31-A | 2 | P32-A | 3 | 28.00 |
| 2 | BLACK | X12M16 | P31-B | ↓ | P32-B | ↓ | 28.00 |
| 3 | RED | P81C16 | P31-C | | P32-C | | 28.00 |
| 4 | RED | P55AC16 | P31-D | | P32-D | | 28.00 |
| 5 | RED | P50M16 | P31-E | | P32-E | | 28.00 |
| 6 | RED | P77AC16 | P31-F | | P32-F | | 28.00 |
| 7 | BLACK | X110C16 | P31-G | | P32-G | | 28.00 |
| 8 | RED | P57H16 | P31-H | | P32-H | | 28.00 |
| 9 | BLACK | X111C16 | P31-J | | P32-J | | 28.00 |
| 10 | RED | [illegible] | P31-K | | P32-K | | 28.00 |

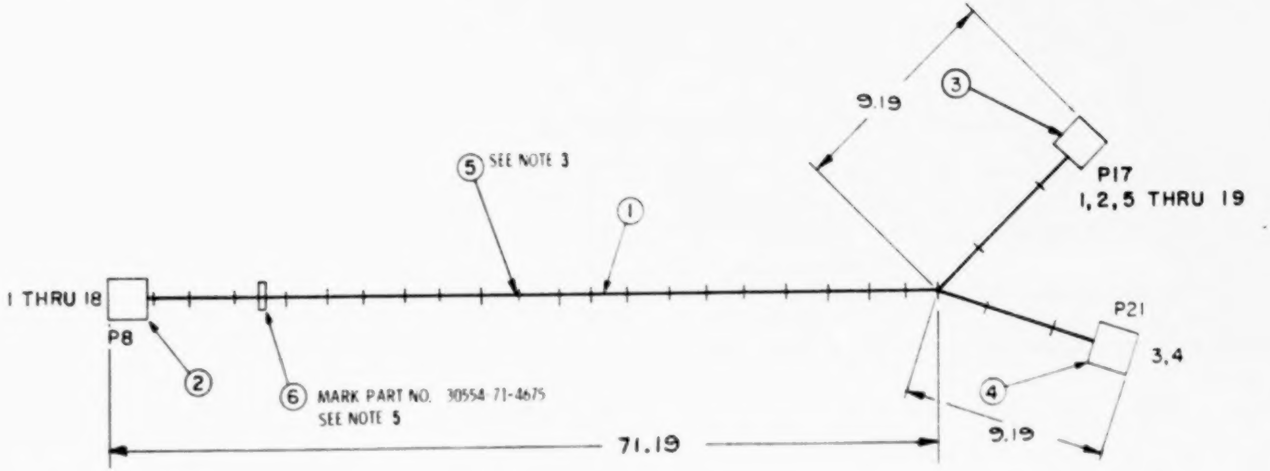
| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 11 | RED | P60D16 | P31-L | | P32-L | | 28.00 |
| 12 | BLACK | X32D16 | P31-M | | P32-M | | 28.00 |
| 13 | BLACK | X33D16 | P31-N | | P32-N | | 28.00 |
| 14 | BLACK | L93D16 | P31-P | | P32-P | | 28.00 |
| 15 | BLACK | X15K16 | P31-R | | P32-R | | 28.00 |
| 16 | BLACK | K102H16 | P31-S | | P32-S | | 28.00 |
| 17 | BLACK | X94D16 | P31-T | | P32-T | | 28.00 |
| 18 | BLACK | X101H16 | P31-U | | P32-U | | 28.00 |
| 19 | RED | P210C16 | P31-V | ↓ | P32-V | ↓ | 28.00 |
| 20 | RED | P55BD16 | P31-Z | 2 | P32-Z | 3 | 28.00 |

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6.
3. CABLE STRAPS, FIND NO. 5 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 5-4. Relay box to precise relay box wire harness



| WIRE NO. | WIRE MARKING IDENTIFICATION COLOR | WIRE MARKING IDENTIFICATION NUMBER | FROM | TERMN FIND NO. | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| 1 | BLACK | X9P16 | P8-A | 2 | P17-A | 3 | 78.00 |
| 2 | BLACK | X12S16 | P8-B | ↑ | P17-B | 3 | 78.00 |
| 3 | RED | P81A16 | P8-C |  | P21-A | 4 | 78.00 |
| 4 | RED | P55AH16 | P8-D |  | P21-B | 4 | 78.00 |
| 5 | BLACK | K105A16 | P8-E |  | P17-E | 3 | 78.00 |
| 6 | BLACK | K107A16 | P8-F |  | P17-F | ↑ | 78.00 |
| 7 | BLACK | K110A16 | P8-G |  | P17-G |  | 78.00 |
| 8 | BLACK | K106A16 | P8-H |  | P17-H |  | 78.00 |
| 9 | BLACK | K111A16 | P8-J |  | P17-J |  | 78.00 |
| 10 | BLACK | K114A16 | P8-K |  | P17-K |  | 78.00 |
| 11 | BLACK | K115A16 | P8-L |  | P17-L |  | 78.00 |
| 12 | BLACK | K32F16 | P8-M |  | P17-M |  | 78.00 |
| 13 | BLACK | K103A16 | P8-N |  | P17-N |  | 78.00 |
| 14 | BLACK | K108A16 | P8-P |  | P17-P |  | 78.00 |
| 15 | BLACK | K109A16 | P8-R |  | P17-R |  | 78.00 |
| 16 | BLACK | K102K16 | P8-S |  | P17-S |  | 78.00 |
| 17 | BLACK | K104A16 | P8-T | ↓ | P17-T |  | 78.00 |
| 18 | BLACK | K101K16 | P8-U | 2 | P17-U | ↑ | 78.00 |
| 19 | BLACK | X113A16 | P17-C | 3 | P17-D | 3 | 3.00 |

| WIRE LENGTH TOLERANCES |  |  |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

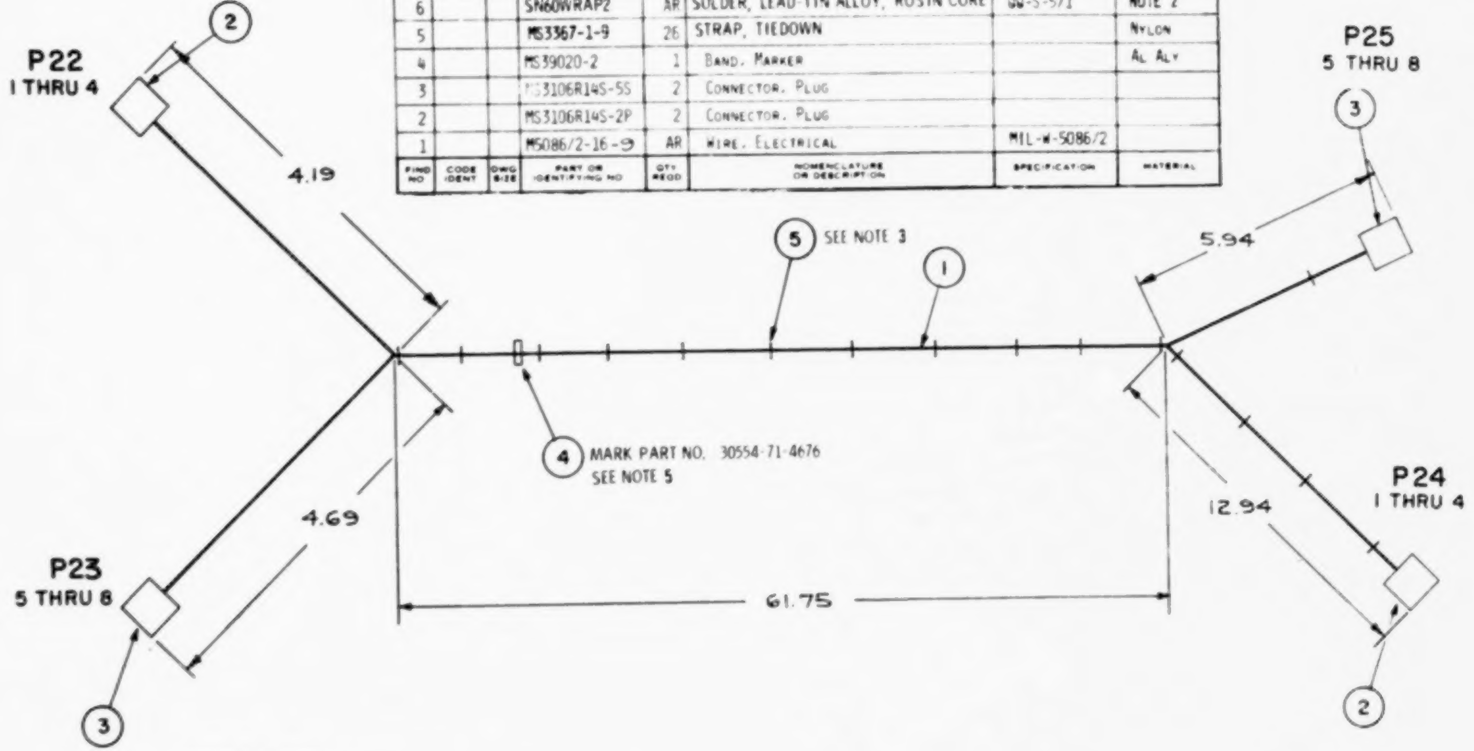
NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 7.
3. CABLE STRAPS, FIND NO. 5 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088. EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 7 |  |  | SN60WRAP2 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 6 |  |  | MS39020-2 | 1 | BAND, MARKER |  | AL ALY |
| 5 |  |  | MS3367-1-9 | 27 | STRAP, TIEDOWN |  | NYLON |
| 4 |  |  | MS3106R10SL-4S | 1 | CONNECTOR, PLUG |  |  |
| 3 |  |  | MS3106R22-14S | 1 | CONNECTOR, PLUG |  |  |
| 2 |  |  | MS3106R24-28P | 1 | CONNECTOR, PLUG |  |  |
| 1 |  |  | M5086-2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 |  |

Figure 5-5. Relay box to governor control unit wire harness precise generator sets

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 6 | | | SN60WRAP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 5 | | | MS3367-1-9 | 26 | STRAP, TIEDOWN | | NYLON |
| 4 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 3 | | | MS3106R14S-5S | 2 | CONNECTOR, PLUG | | |
| 2 | | | MS3106R14S-2P | 2 | CONNECTOR, PLUG | | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |



| WIRE NO. | WIRE MARKING IDENTIFICATION COLOR | NUMBER | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| 1 | BLACK | K120A16 | P22-A | 2 | P24-A | 2 | 76.00 |
| 2 | BLACK | K121A16 | P22-B | 2 | P24-B | 2 | 76.00 |
| 3 | BLACK | K122A16 | P22-C | 2 | P24-C | 2 | 76.00 |
| 4 | BLACK | K123A16 | P22-D | 2 | P24-D | 2 | 76.00 |
| 5 | BLACK | K124A16 | P23-A | 3 | P25-A | 3 | 70.00 |
| 6 | BLACK | K125A16 | P23-B | 3 | P25-B | 3 | 70.00 |
| 7 | BLACK | K126A16 | P23-C | 3 | P25-C | 3 | 70.00 |
| 8 | BLACK | K127A16 | P23-D | 3 | P25-D | 3 | 70.00 |

WIRE LENGTH TOLERANCES

| OVER | INCL. | TOL. ± |
|---|---|---|
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6.
3. CABLE STRAPS, FIND NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088. EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 5-6. Governor control unit to governor actuator unit wire harness, precise generator sets

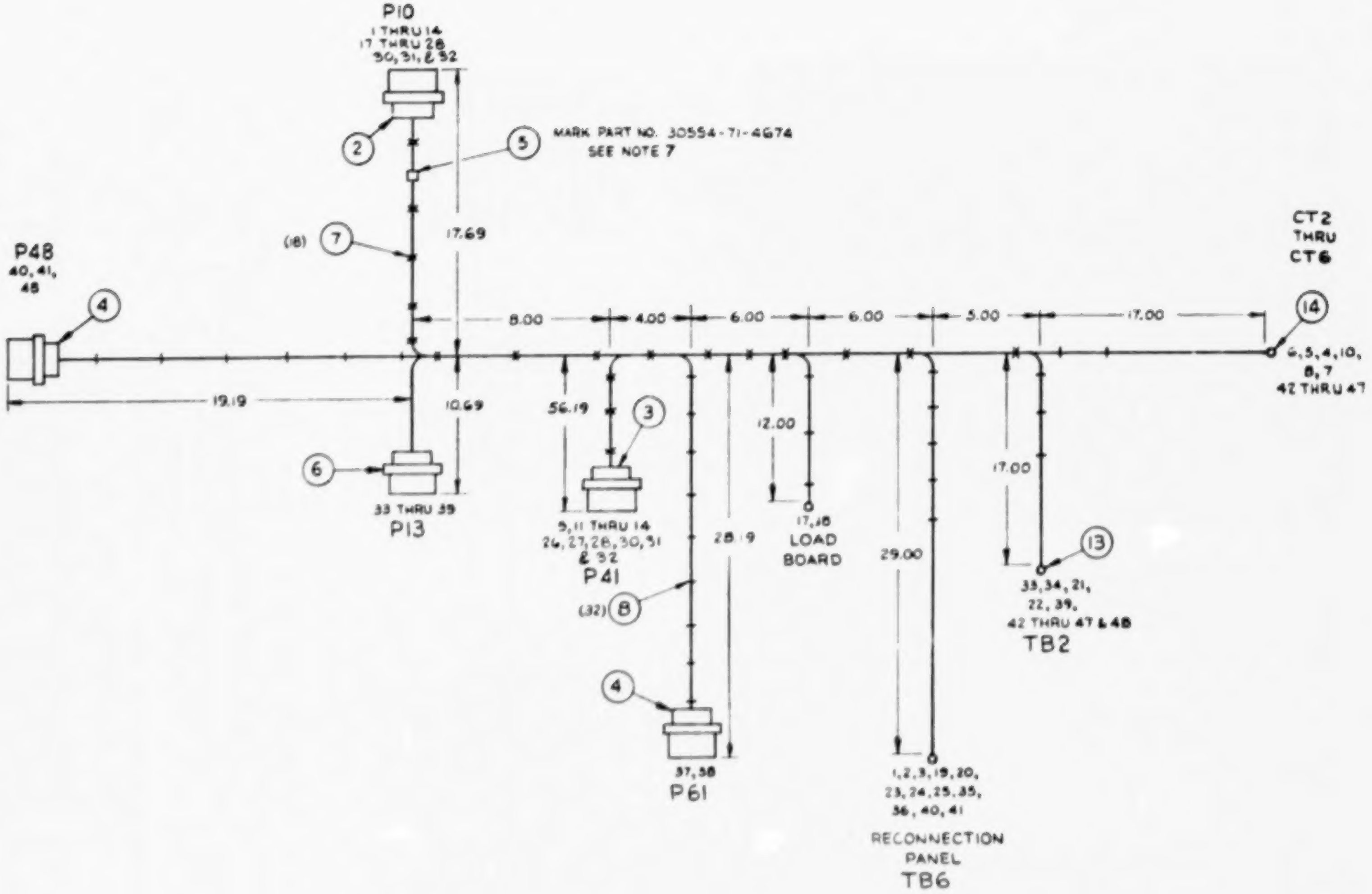

P10
1 THRU 14
17 THRU 28
30, 31, & 32
2
5
MARK PART NO. 30554-71-4674
SEE NOTE 7
(18)
7
17.69
P48
40, 41,
48
4
CT2
THRU
CT6
14
8.00
4.00
6.00
6.00
5.00
17.00
6, 5, 4, 10,
8, 7
42 THRU 47
19.19
10.69
56.19
3
12.00
17.00
6
33 THRU 39
P13
9, 11 THRU 14
26, 27, 28, 30, 31
& 32
P41
28.19
17, 18
LOAD
BOARD
29.00
13
33, 34, 21,
22, 39,
42 THRU 47 & 48
TB2
(32)
8
4
37, 38
P61
1, 2, 3, 19, 20,
23, 24, 25, 35,
36, 40, 41
RECONNECTION
PANEL
TB6

Figure 5-7. Relay box to reconnection panel wire harness (sheet 1 of 2)

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG (REF) |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | X7E16 | P10-A | 2 | TB6-7 | 12 | 72.00 |
| 2 | BLACK | X8E16 | P10-B | ↑ | TB6-8 | 12 | 72.00 |
| 3 | BLACK | X9AA16 | P10-C | | TB6-9 | 12 | 72.00 |
| 4 | BLACK | X19B16 | P10-D | | CT3-X1 | 14 | 65.00 |
| 5 | BLACK | X18B16 | P10-E | | CT2-X1 | 14 | 65.00 |
| 6 | BLACK | X17B16 | P10-F | | CT1-X1 | 14 | 65.00 |
| 7 | BLACK | D22E16 | P10-G | | CT3-X2 | 14 | 65.00 |
| 8 | BLACK | D21E16 | P10-H | | CT2-X2 | 14 | 65.00 |
| 9 | BLACK | P40AC16 | P10-V | | P41-M | 3 | 82.00 |
| 10 | BLACK | D20E16 | P10-J | | CT1-X2 | 14 | 65.00 |
| 11 | BLACK | K110E16 | P10-K | | P41-H | 3 | 82.00 |
| 12 | RED | P55K16 | P10-L | | P41-B | 3 | 82.00 |
| 13 | RED | P63E16 | P10-M | ↓ | P41-A | 3 | 82.00 |
| 14 | RED | P50FF16 | P10-N | 2 | P41-D | 3 | 82.00 |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | BLACK | X21S16 | P10-S | 2 | L1 | 15 | 48.00 |
| 18 | BLACK | X22S16 | P10-T | ↑ | L2 | 15 | 48.00 |
| 19 | BLACK | X12X16 | P10-W | | TB6-12 | 12 | 72.00 |
| 20 | BLACK | X6B16 | P10-X | | TB6-6 | 12 | 72.00 |
| 21 | BLACK | X194F16 | P10-Y | | TB2-5 | 13 | 65.00 |
| 22 | BLACK | X195E16 | P10-Z | | TB2-6 | 13 | 65.00 |
| 23 | BLACK | X14A16 | P10-a | ↓ | TB6-1 | 12 | 72.00 |
| 24 | BLACK | X15F16 | P10-b | 2 | TB6-2 | 12 | 72.00 |
| 25 | BLACK | X16A16 | P10-d | 2 | TB6-3 | 12 | 72.00 |
| 26 | RED | P56J16 | P10-c | ↑ | P41-C | 3 | 82.00 |
| 27 | RED | P50NN16 | P10-e | ↓ | P41-J | 3 | 82.00 |
| 28 | RED | P199D16 | P10-f | 2 | P41-K | 3 | 82.00 |
| 29 | | | | | | | |
| 30 | BLACK | X97B16 | P10-g | 2 | P41-E | 3 | 82.00 |
| 31 | BLACK | X98B16 | P10-h | 2 | P41-F | 3 | 82.00 |
| 32 | BLACK | K112B16 | P10-j | 2 | P41-G | 3 | 82.00 |
| 33 | BLACK | U134B16 | P13-J | 6 | TB2-4 | 13 | 58.00 |
| 34 | BLACK | U135B16 | P13-K | ↑ | TB2-2 | 13 | 58.00 |
| 35 | BLACK | X9CD16 | P13-L | | TB6-9 | 12 | 72.00 |
| 36 | BLACK | X12SS16 | P13-P | | TB6-12 | 12 | 72.00 |
| 37 | RED | P73C16 | P13-R | | P61-C | 4 | 52.00 |
| 38 | RED | P67E16 | P13-S | ↓ | P61-B | 4 | 52.00 |
| 39 | RED | P55AL16 | P13-T | 6 | GRD LUG | 13 | 58.00 |
| 40 | RED | X12MM12 | P48-C | 4 | TB6-12 | 11 | 72.00 |
| 41 | RED | X9MM12 | P48-B | 4 | TB6-9 | 11 | 72.00 |
| 42 | BLACK | U135A16 | TB2-1 | 13 | CT6-X2 | 14 | 34.00 |
| 43 | BLACK | U135E16 | TB2-2 | 13 | CT4-X2 | 14 | ↑ |
| 44 | BLACK | U135F16 | TB2-2 | 13 | CT5-X2 | 14 | |
| 45 | BLACK | U134A16 | TB2-3 | 13 | CT6-X1 | 14 | |
| 46 | BLACK | U134E16 | TB2-4 | 13 | CT4-X1 | 14 | ↓ |
| 47 | BLACK | U134F16 | TB2-4 | 13 | CT5-X1 | 14 | 34.00 |

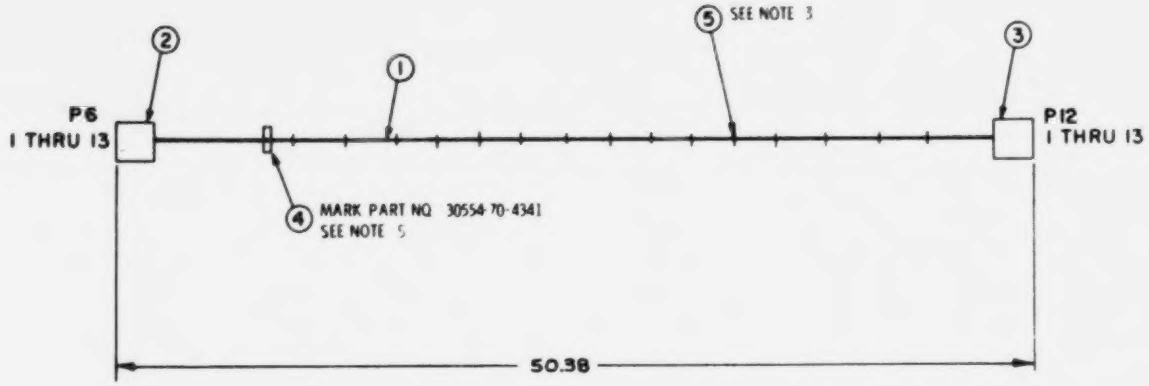
| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 15 | | | MS25036-154 | 2 | TERMINAL, LUG | | |
| 14 | | | MS25036-108 | 12 | TERMINAL, LUG | | |
| 13 | | | MS25036-106 | 12 | TERMINAL, LUG | | |
| 12 | | B | 71-4931-01 | 10 | TERMINAL, LUG | | |
| 11 | | B | 71-4931-02 | 2 | TERMINAL, LUG | | |
| 10 | | | SN60WRAP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 3 |
| 9 | | | M5086/2-12-9 | AR | WIRE ELECTRICAL | MIL-W-5086/2 | |
| 8 | | | MS3367-4-9 | 32 | STRAP, TIEDOWN | | NYLON |
| 7 | | | MS3367-1-9 | 18 | STRAP, TIEDOWN | | NYLON |
| 6 | | | MS3106R22-14S | 1 | CONNECTOR, PLUG | | |
| 5 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 4 | | | MS3106R18-5S | 2 | CONNECTOR, PLUG | | |
| 3 | | | MS3106R20-29S | 1 | CONNECTOR, PLUG | | |
| 2 | | | MS3106R32-7S | 1 | CONNECTOR, PLUG | | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 10. SOLDER CONNECTIONS PER MIL-STD-454, REQT 5.
3. CABLE STRAPS, FIND NO.'S 7 & 8 SHALL BE SPACED AT APPROX 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. A. TRUNK TO BE 1.00 RADIUS EXCEPT WHERE OTHERWISE SPECIFIED
   B. BREAKOUTS TO BE .50 RADIUS.
6. FOR NEXT ASSEMBLY SEE DRAWING 71-4408
   PART NO. MARKING TO BE METAL STAMPED IN
7. ACCORDANCE WITH MIL-STD-130.

Figure 5-7. Relay box to reconnection panel wire harness (sheet 2 of 2)



| WIRE NO. | WIRE MARKING IDENTIFICATION COLOR | WIRE MARKING IDENTIFICATION NUMBER | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| 1 | RED | P45K16 | P6-A | 2 | P12-A | 3 | 48.00 |
| 2 | RED | P66A16 | P6-B | ↑ | P12-B | ↑ | 48.00 |
| 3 | RED | P200A16 | P6-C |  | P12-C |  | 48.00 |
| 4 | RED | P201A16 | P6-D |  | P12-D |  | 48.00 |
| 5 | RED | P202A16 | P6-E |  | P12-E |  | 48.00 |
| 6 | RED | P203A16 | P6-F |  | P12-F |  | 48.00 |
| 7 | RED | P204A16 | P6-G |  | P12-G |  | 48.00 |
| 8 | RED | P205A16 | P6-H |  | P12-H |  | 48.00 |
| 9 | RED | P206A16 | P6-I |  | P12-I |  | 48.00 |
| 10 | RED | P207A16 | P6-K |  | P12-K |  | 48.00 |
| 11 | RED | P208A16 | P6-L |  | P12-L |  | 48.00 |
| 12 | RED | P209A16 | P6-M | ↓ | P12-M | ↓ | 48.00 |
| 13 | RED | P210A16 | P6-N | 2 | P12-N | 3 | 48.00 |

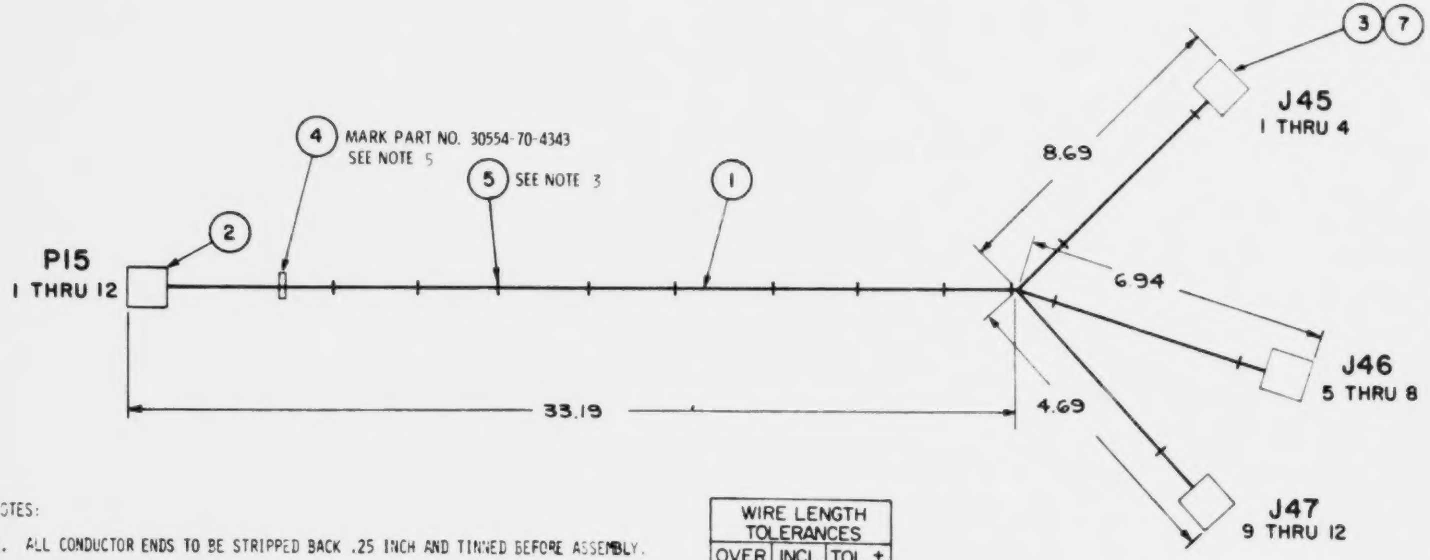
| WIRE LENGTH TOLERANCES |  |  |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| 6 |  |  | SN60WRAP2 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 5 |  |  | MS3367-1-9 | 15 | STRAP, TIEDOWN |  | NYLON |
| 4 |  |  | MS39020-2 | 1 | BAND, MARKER |  | AL ALY |
| 3 |  |  | MS3106R20-27S | 1 | CONNECTOR, PLUG |  |  |
| 2 |  |  | MS3106R20-27P | 1 | CONNECTOR, PLUG |  |  |
| 1 |  |  | M5086/2 16 9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 |  |
| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6 .
3. CABLE STRAPS, FIND NO. 5 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 5-8. Relay box to fault locator indicator wire harness



NOTES:

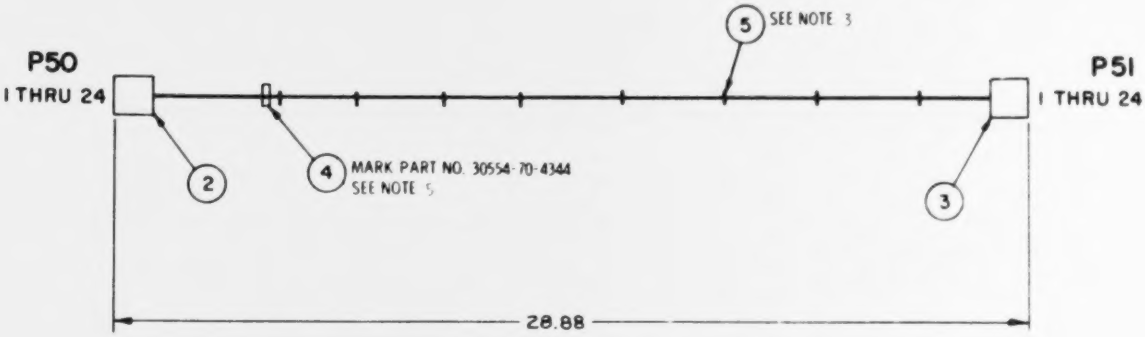
1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6 .
3. CABLE STRAPS, FIND NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 7 | | | TYPE F, FORM U<br>GRADE A, CL I<br>CATEGORY 1 | 12 | TUBING, INSULATION<br>.106 ID X .016 WALL X .62 LG | MIL-I-631 | |
| 6 | | | SN60WRAP2 | AP | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 5 | | | MS3367-1-9 | 15 | STRAP, TIEDOWN | | NYLON |
| 4 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 3 | | | MS3102R18-4P | 3 | CONNECTOR, RECEPTACLE | | |
| 2 | | | MS3106R20-29P | 1 | CONNECTOR, PLUG | | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | K112E16 | P15-A | 2 | J45-A | 3 | 37.00 |
| 2 | BLACK | K111F16 | P15-B | ↑ | J45-B | ↑ | 37.00 |
| 3 | BLACK | X98E16 | P15-C | | J45-C | | 37.00 |
| 4 | BLACK | X96C16 | P15-D | | J45-D | | 37.00 |
| 5 | BLACK | K112H16 | P15-E | | J46-A | | 41.00 |
| 6 | BLACK | K111J16 | P15-F | | J46-B | | 41.00 |
| 7 | BLACK | X98H16 | P15-G | | J46-C | | 41.00 |
| 8 | BLACK | X96E16 | P15-H | | J46-D | | 41.00 |
| 9 | BLACK | K112K16 | P15-J | | J47-A | | 39.00 |
| 10 | BLACK | K111L16 | P15-K | | J47-B | | 39.00 |
| 11 | BLACK | X98K16 | P15-L | ↓ | J47-C | ↓ | 39.00 |
| 12 | BLACK | X96H16 | P15-M | 2 | J47-D | 3 | 39.00 |

Figure 5-9. Parallel receptacle wire harness



| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | RED | P58C16 | P50-A | 2 | P51-A | 3 | 26.50 |
| 2 | RED | P50S16 | P50-B | ↑ | P51-B | ↑ | 26.50 |
| 3 | RED | P206C16 | P50-C | | P51-C | | 26.50 |
| 4 | RED | P205C16 | P50-D | | P51-D | | 26.50 |
| 5 | RED | P60B16 | P50-E | | P51-E | | 26.50 |
| 6 | RED | P203C16 | P50-F | | P51-F | | 26.50 |
| 7 | RED | P209C16 | P50-G | | P51-G | | 26.50 |
| 8 | RED | P62J16 | P50-H | | P51-H | | 26.50 |
| 9 | BLACK | X9U16 | P50-J | | P51-J | | 26.50 |
| 10 | BLACK | X12BB16 | P50-K | | P51-K | | 26.50 |
| 11 | RED | P50AK16 | P50-L | | P51-L | | 26.50 |
| 12 | RED | P55Z16 | P50-M | | P51-M | | 26.50 |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 13 | BLACK | X102E16 | P50-N | | P51-N | | 26.50 |
| 14 | RED | P200T16 | P50-P | | P51-P | | 26.50 |
| 15 | BLACK | X8J16 | P50-R | | P51-R | | 26.50 |
| 16 | BLACK | X7J16 | P50-S | | P51-S | | 26.50 |
| 17 | BLACK | X17D16 | P50-T | | P51-T | | 26.50 |
| 18 | BLACK | X18D16 | P50-U | | P51-U | | 26.50 |
| 19 | BLACK | X19D16 | P50-V | | P51-V | | 26.50 |
| 20 | RED | P55BC16 | P50-W | | P51-W | | 26.50 |
| 21 | BLACK | X101E16 | P50-X | | P51-X | | 26.50 |
| 22 | RED | P63B16 | P50 a | | P51 a | | 26.50 |
| 23 | RED | P62E16 | P50 b | ↓ | P51 b | ↓ | 26.50 |
| 24 | BLACK | X24F16 | P50 d | 2 | P51 d | 3 | 26.50 |

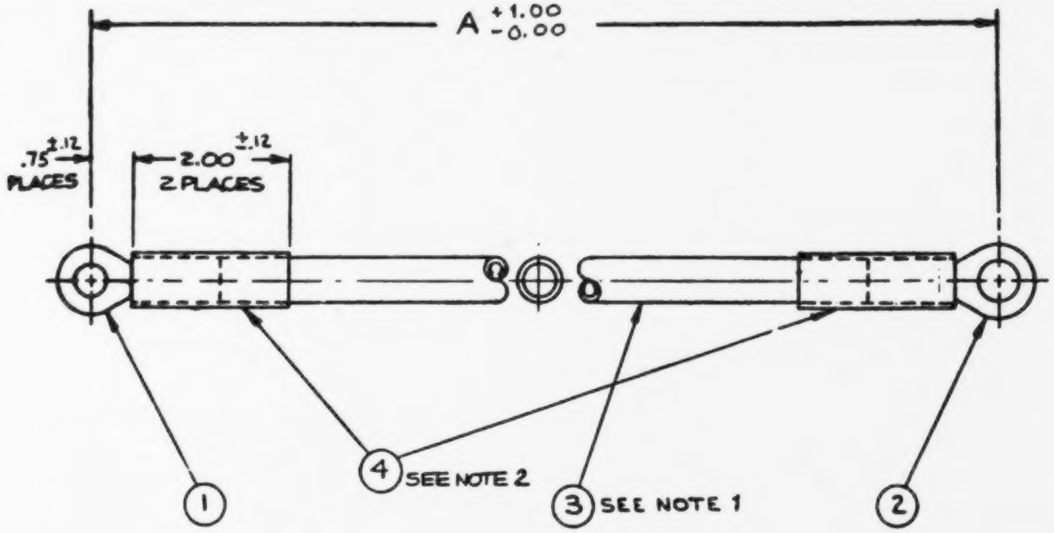
NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 6
3. CABLE STRAPS, FIND NO. 5 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 6 | | | SN60WRAP2 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 5 | | | MS3367-1-9 | 8 | STRAP, TIEDOWN | | NYLON |
| 4 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 3 | | | MS3106R28-12S | 1 | CONNECTOR, PLUG | | |
| 2 | | | MS3106R28-12P | 1 | CONNECTOR, PLUG | | |
| 1 | | | M5086/2 16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

Figure 5-10. Relay box to tactical relay box wire harness



| PT.NO. | DIM."A" | FROM | TO |
|---|---|---|---|
| 71-4568-01 | 68.00 | B1(-) | SR2(-) |

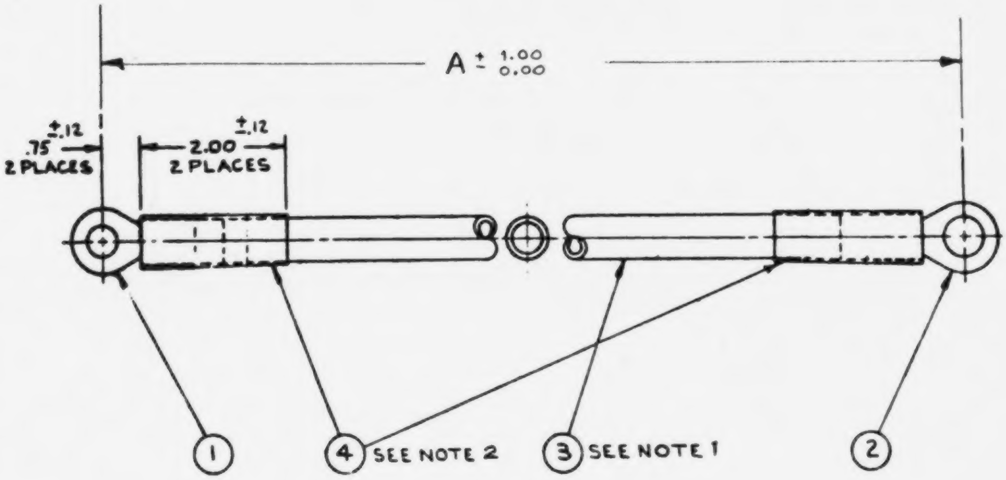
NOTES:

1. STRIP INSULATION .62 LONG FROM BOTH ENDS OF WIRE (FIND NO. 3). CRIMP TERMINALS (FIND NO'S. 1 & 2) ONTO WIRE, ORIENT TERMINALS IN POSITION SHOWN.

2. AFTER PLACING INSULATION (FIND NO. 4) ON WIRE (FIND NO. 3). APPLY HEAT OF 400°F FOR 3-5 SECONDS TO OBTAIN PROPER SHRINKAGE.

| FIND NO. | PART NO. | QTY RQD | DESCRIPTION | SPEC. |
|---|---|---|---|---|
| 1 | MS20659-118 | 1 | TERMINAL, LUG | |
| 2 | MS20659-135 | 1 | TERMINAL, LUG | |
| 3 | | A/R | WIRE, ELECTRICAL 1/0 | MIL-C-5756 |
| 4 | CLASS 1 | A/R | INSUL, SLEEVING, 1.00 ID BLK | MIL-I-23053/5 |

Figure 5-11. Starter motor to slave receptacle electrical leads



TABULATION

| PART NO. | DIM. "A" | FROM | TO |
|---|---|---|---|
| 71-4567-01 | 68.00 | L4 | SR2(+) |

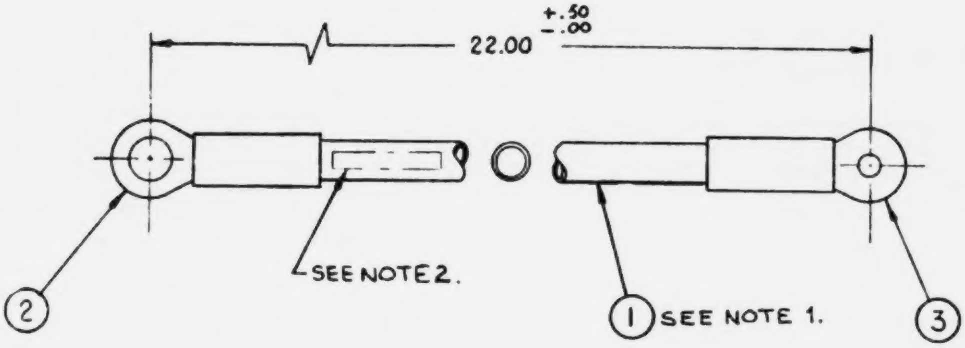
NOTES:

1. STRIP INSULATION .62 LONG FROM BOTH ENDS OF WIRE (FIND NO. 3). CRIMP TERMINALS (FIND NO'S. 1 & 2) ONTO WIRE. ORIENT TERMINALS IN POSITION SHOWN.

2. AFTER PLACING INSULATION (FIND NO. 4) ON WIRE (FIND NO. 3). APPLY HEAT OF 400°F FOR 3-5 SECONDS TO OBTAIN PROPER SHRINKAGE.

| FIND NO. | PART NO. | QTY RQD | DESCRIPTION | SPEC. |
|---|---|---|---|---|
| 1 | MS20659-118 | 1 | TERMINAL, LUG | |
| 2 | MS20659-135 | 1 | TERMINAL, LUG | |
| 3 | | A/R | WIRE, ELECTRICAL 1/0 | MIL-C-5756 |
| 4 | CLASS 1 | A/R | INSUL, SLEEVING, 1.00 ID, RED | MIL-I-23053/5 |

Figure 5-12. Starter solenoid to slave receptacle electrical leads



| FROM | TO |
|---|---|
| B1(-) | GROUND |

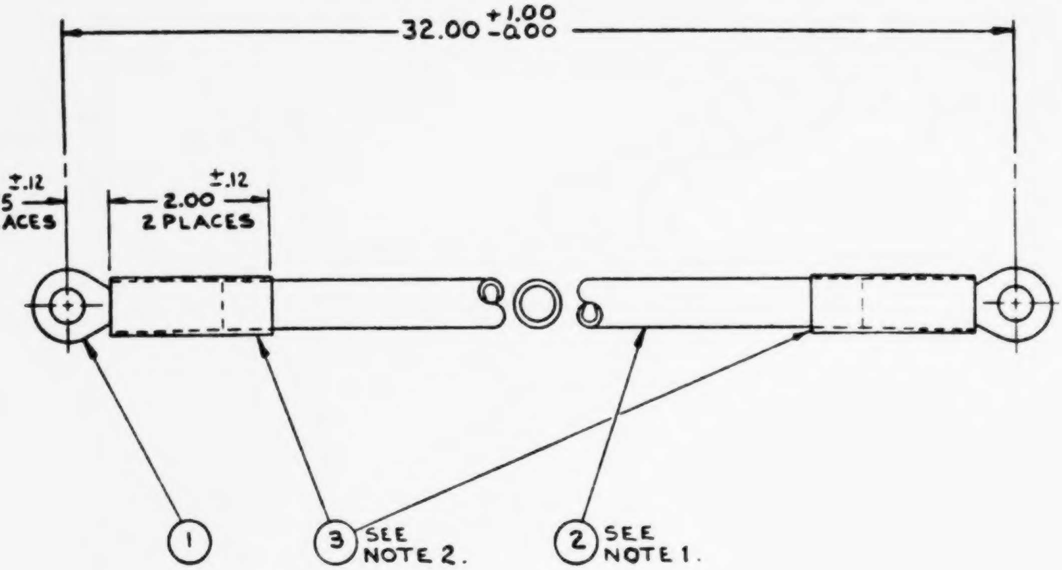
NOTES:

1. STRIP INSULATION .62 LONG FROM BOTH ENDS OF WIRE, FIND NO. 1. CRIMP TERMINALS, FIND NO. 2 AND 3 ONTO WIRE, ORIENT TERMINALS IN POSITION SHOWN.
2. STAMP PART NO. AS SHOWN BELOW PER MIL-STD-130, .12 MIN. HIGH USING BLACK INK.

30554-71-4789

| FIND NO. | PART NO. | QTY RQD | DESCRIPTION | SPEC. |
|---|---|---|---|---|
| 1 | M5086/2-01-9 | A/R | WIRE, ELECTRICAL, 1/0 | MIL-W-5086 |
| 2 | MS25036-134 | 1 | TERMINAL, LUG | |
| 3 | MS25036-132 | 1 | TERMINAL, LUG | |

Figure 5-13. Starter motor to ground electrical lead


32.00 +1.00 -0.00
.75 ±.12
2 PLACES
2.00 ±.12
2 PLACES
①
③ SEE NOTE 2.
② SEE NOTE 1.

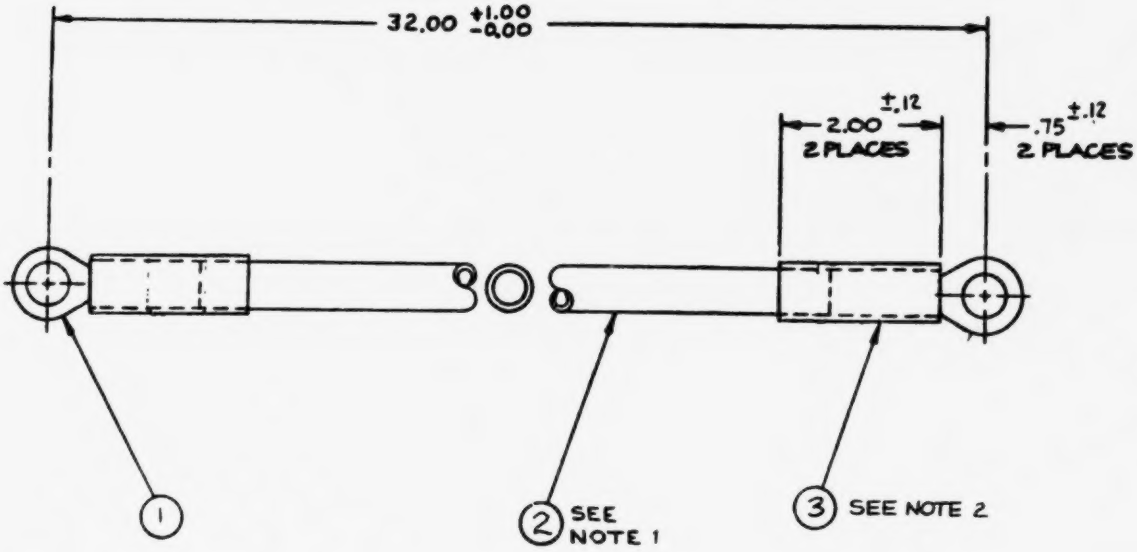
| FROM | TO |
|---|---|
| TB1(+) | SR2(+) |

NOTES:

1. STRIP INSULATION .62 LONG FROM BOTH ENDS OF CABLE (FIND NO. 2). CRIMP TERMINALS (FIND NO. 1) ONTO CABLE & ORIENT TERMINALS IN POSITION SHOWN.
2. AFTER PLACING INSULATION (FIND NO. 3) ON CABLE (FIND NO. 2). APPLY HEAT OF 400° F FOR 3-5 SECONDS TO OBTAIN PROPER SHRINKAGE.

| FIND NO. | PART NO. | QTY RQD | DESCRIPTION | SPEC. |
|---|---|---|---|---|
| 1 | MS20659-118 | 2 | TERMINAL, LUG | |
| 2 | | A/R | WIRE, ELECTRICAL 1/0 | MIL-C-5756 |
| 3 | CLASS 1 | A/R | INSUL, SLEEVING, 1.00 ID, RED | MIL-I-23053/5 |

Figure 5-14. Slave receptacle to battery terminal block positive electrical leads


32.00 +1.00 -0.00
2.00 ±.12
2 PLACES
.75 ±.12
2 PLACES
1
2 SEE NOTE 1
3 SEE NOTE 2

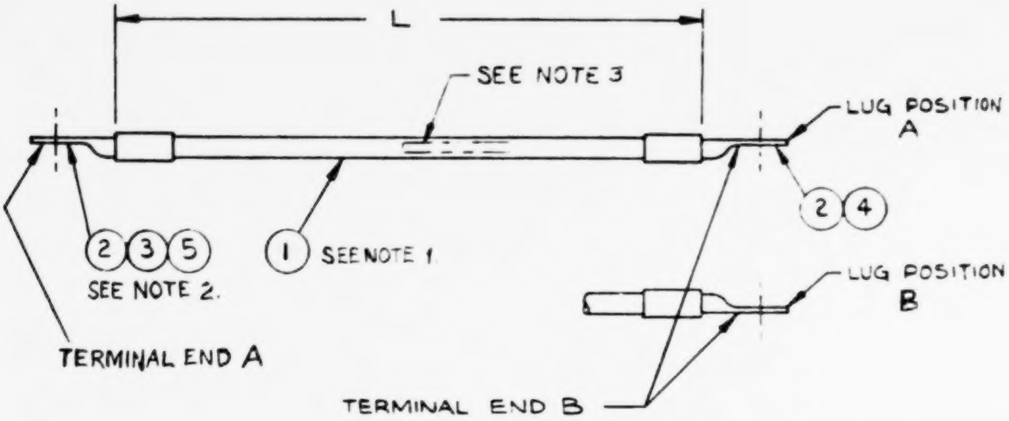
| FROM | TO |
|---|---|
| TB1(-) | SR2(-) |

NOTES:

1. STRIP INSULATION .62 LONG FROM BOTH ENDS OF CABLE (FIND NO. 2). CRIMP TERMINALS (FIND NO. 1) ONTO CABLE & ORIENT TERMINALS IN POSITION SHOWN.
2. AFTER PLACING INSULATION (FIND NO. 3) ON CABLE (FIND NO. 2). APPLY HEAT OF 400° F FOR 3-5 SECONDS TO OBTAIN PROPER SHRINKAGE.

| FIND NO. | PART NO. | QTY RQD | DESCRIPTION | SPEC. |
|---|---|---|---|---|
| 1 | MS20659-118 | 2 | TERMINAL, LUG | |
| 2 | | A/R | WIRE, ELECTRICAL 1/0 | MIL-C-5756 |
| 3 | CLASS 1 | A/R | INSUL, SLEEVING, 1.00 ID, RED | MIL-I-23053/5 |

Figure 5-15. Slave receptacle to battery terminal block negative electrical lead



| TABULATION | | | | | | |
|---|---|---|---|---|---|---|
| PART NO. | WIRE LENGTH L | FIND NO. (TERM END A) | FIND NO. (TERM END B) | LUG POSITION | FROM | TO |
| 71-4745-02 | 16.00 | 5 | 4 | A | TB6-13 | LO-B |
| -03 | 21.00 | 5 | 4 | A | TB6-13 | LO-A |
| -04 | 29.50 | 2 | 4 | B | CB2-A2 | L1-B |
| -05 | 26.00 | 2 | 4 | A | CB2-A2 | L1-A |
| -06 | 45.00 | 5 | 2 | B | CB2-B1 | TB6-2 |
| -07 | 33.00 | 2 | 4 | B | CB2-B2 | L2-B |
| -08 | 50.00 | 5 | 2 | B | CB2-A1 | TB6-1 |
| -09 | 30.00 | 2 | 4 | A | CB2-B2 | L2-A |
| -10 | 42.00 | 5 | 2 | B | CB2-B1<br>CB2-C1 | TB6-2<br>TB6-3 |
| -11 | 45.00 | 2 | 4 | B | CB2-C2 | L3-B |
| 71-4745-12 | 41.00 | 2 | 4 | A | CB2-C2 | L3-A |

NOTES:

1. STRIP INSULATION, FROM FIND NO. 1, .75 LONG FROM TERMINAL LUG ENDS.
2. CRIMP TERMINAL LUGS (FIND NO. 2, 3, 4 &5) ON CABLE (FIND NO. 1) AS SHOWN IN TABLE IN REGARD TO FIND NO., QTY. AND ORIENTATION OF LUGS.
3. STAMP PART NO. AS SHOWN BELOW PER MIL-STD-130, .12 MIN. HIGH USING BLACK INK.

30554-71-4745- ☐ (ADD DASH NO.)

| FIND NO. | PART NO. | QTY RQD | DESCRIPTION | SPEC. |
|---|---|---|---|---|
| 1 | M5086/2-04-9 | A/R | WIRE, ELECTRICAL | MIL-W-5086 |
| 2 | MS25036-140 | 9 | TERM. LUG | |
| 3 | MS25036-141 | 1 | TERM. LUG | |
| 4 | 71-4878-01 | 9 | TERM. LUG | |
| 5 | 71-4878-02 | 5 | TERM. LUG | |

Figure 5-16. Circuit breaker and load board electrical leads

# CHAPTER 6

# GENERATOR SET CONTROL GROUP REPAIR INSTRUCTIONS

## Section I. CONTROL CUBICLE

### 6-1. GENERAL.

The control cubicle is located at the generator end of the set. It contains controls, switches, instruments, and circuitry necessary to start, operate, and monitor the generator set. The instruments and controls are mounted on a hinged front panel of the cubicle which permits easy access to the interior of the cubicle. Devices on the front panel are divided into an engine group and a generator group.

a. Instruments that monitor the generator output are: frequency meter M6; kilowatt meter M7; percent rated current meter M8; ac voltmeter M9; ammeter-voltmeter selector switch S8; and the synchronizing lights DS4 and DS5. Devices that control the generator output are: a frequency adjust rheostat R1 for precise sets; a voltage adjust rheostat R2; parallel unit - single unit operation switch S6; battle short switch S7 and indicator DS7; voltage sensing (remote-local) switch S5; and ac load contactor switch S3 and indicator DS6. Utility generator sets utilize a manual speed control located adjacent to the control cubicle, for adjustment of frequency through the utility governor.

b. Instruments that monitor engine operation are: oil pressure meter M1; coolant temperature indicator M2, fuel level meter M3, battery charge ammeter M4, and total running time meter M5. Devices that control the engine are a START-RUN-STOP switch S2 and an engine primer switch S1. Also included is an engine air cleaner condition indicator DS8.

c. Located in the control cubicle are the thermal watt converter A1, control panel relay assembly A4, frequency meter transducer A2, control box relay assembly, and a wire harness. The thermal watt converter senses the generator power output and converts it to a proportional dc signal for display by the kilowatt meter. The frequency meter and transducer are a matched set. A single phase ac voltage of the generator output is applied to the transducer which produces dc signal proportional to the generator frequency for display by the frequency meter. The control box relay assembly contains stop-run relay K1, remote voltage sensing relay K6, rectifier bridge CR1, and resistor R10.

### 6-2. THERMAL WATT CONVERTER (A1).

### 6-3. TEST ON EQUIPMENT.

a. Symptoms and Isolation of Malfunction. A malfunction of the thermal watt converter is usually indicated by low or no kilowatt meter reading. An open circuit coil in the thermal watt converter will also effect the AC ammeter reading for the phase which is open. To isolate the malfunction, proceed as follows:

1. Loosen three captive studs and hinge control box door open.

2. Start generator set and apply load.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

3. Measure input voltages at terminals V1-N1, V2-N2 and V3-N3. Voltage should be 120 VAC with the generator output voltage adjusted for rated output. If above requirement is not met, check wiring back to voltage source.

4. Measure current to terminal L1, L2, and L3. The current should vary between 0-0.75 AC amperes as the generator set load is varied from 0 to 100 percent of rated output. If there is no current shut down generator set and check for continuity between terminals L1-S1, L2-S2 and L3-S3. If there is continuity, check wiring back to current source.

5. Measure the output signal at the (+) and (-) terminals with a vacuum tube DC voltmeter. The output signal should vary between 0 to 10.4 mv as the generator set load is varied between 0 and 100 percent of rated output. If the above requirement is not met and the inputs are correct, the thermal watt converter should be replaced.

b. Removal. Refer to Operator and Organizational Maintenance Manual and remove the thermal watt converter.

6-4. CLEANING. Clean the thermal watt converter using a clean lint-free cloth, moistened with an approved cleaning solvent and dry thoroughly.

6-5. INSPECTION. Inspect case for evidence of cracks or tears and the terminal board for cracked insulation, stripped threads, and missing jumper strips.

6-6. TEST. Connect the thermal watt converter to the test equipment as illustrated in figure 6-1 and proceed as follows:

Note

All test readings are ±20 percent.

a. Adjust all autotransformers T1, T2, and T3 to their MIN positions.

b. Close switch S1 and open switches S2 and S3.

c. Energize the power source.

d. Adjust T1 until 1 ampere is indicated on ammeter A1. Voltmeter V1 should indicate 6.4 mv.

e. Close switch S2 and adjust T2 until 1 ampere is indicated on ammeter A2. Voltmeter V1 should indicate 13 mv.

f. Close switch S3 and adjust T3 until 1 ampere is indicated on ammeter A3. Voltmeter should indicate 18.6 mv.

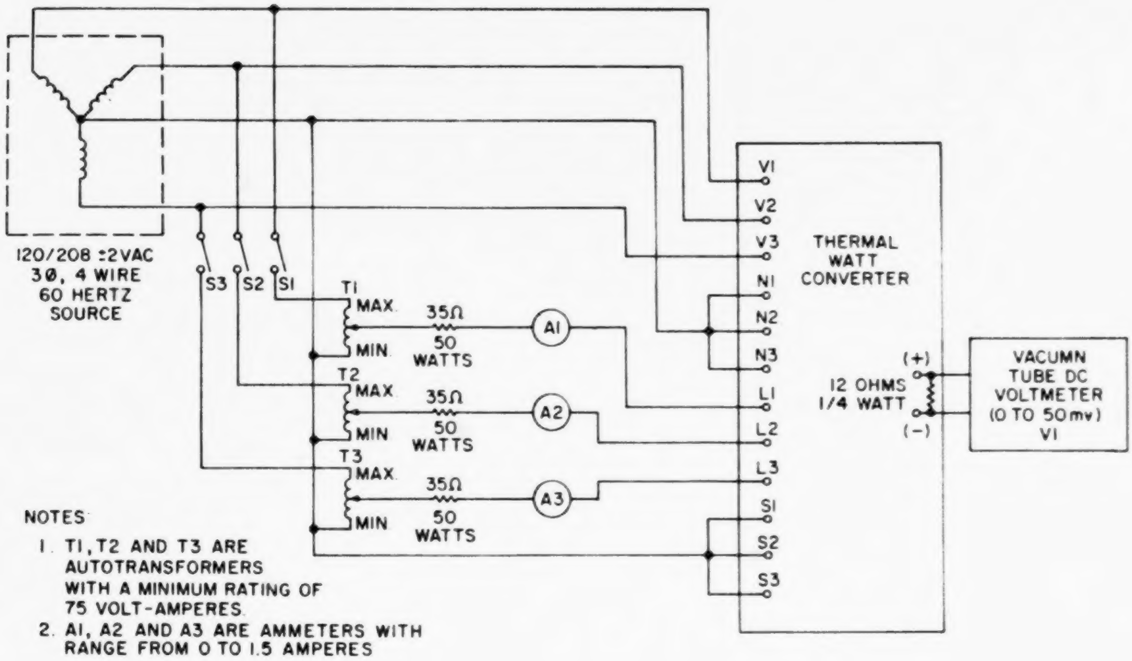
g. Remove test equipment. Replace defective thermal watt converter.

6-7. INSTALLATION. Refer to Operator and Organizational Maintenance Manual and install the thermal watt converter.

## 6-8. FREQUENCY METER (M6) AND TRANSDUCER (A2).

6-9. TEST ON EQUIPMENT.

a. Symptoms and Isolation of Malfunction. A malfunction of the frequency meter or transducer is usually indicated by off


120/208 ±2VAC
3Ø, 4 WIRE
60 HERTZ
SOURCE
S3
S2
S1
T1
MAX
MIN
T2
MAX
MIN
T3
MAX
MIN
35Ω
50 WATTS
35Ω
50 WATTS
35Ω
50 WATTS
A1
A2
A3
V1
V2
V3
N1
N2
N3
L1
L2
L3
S1
S2
S3
THERMAL WATT CONVERTER
(+)
12 OHMS
1/4 WATT
(-)
VACUMN TUBE DC VOLTMETER (0 TO 50mv) V1

NOTES

1. T1, T2 AND T3 ARE AUTOTRANSFORMERS WITH A MINIMUM RATING OF 75 VOLT-AMPERES.
2. A1, A2 AND A3 ARE AMMETERS WITH RANGE FROM 0 TO 1.5 AMPERES

Figure 6-1. Thermal watt converter (A1) test setup

scale, high or low readings with the frequency adjusting controls set in their normal positions. To isolate the malfunction, proceed as follows:

1. Loosen three captive studs and hinge control box door open.

2. Start generator set and apply load.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

3. Measure input voltage to frequency transducer (A2) at terminal 1 and 2. Voltage should be 120 ± 10 percent vac, if not check wiring back to voltage source.

4. Connect a test frequency meter (table 2-1) to the convenience receptacle or generator output terminal. Check panel frequency meter accuracy against test meter while varying engine speed using manual speed control on utility generator sets or frequency adjust rheostat on precise generator sets. If meters do not indicate the same, replace frequency meter and transducer.

b. Removal. Refer to Operator and Organizational Maintenance Manual and remove the frequency meter and transducer.

6-10. CLEANING. Clean the frequency meter and transducer using a clean lint-free cloth, moistened with an approved cleaning solvent and dry thoroughly.

6-11. INSPECTION. Inspect the frequency meter and transducer cases for cracks or tears and the electrical connectors for bent pins and insulation breakdown.

6-12. TEST.

NOTE

The frequency meter and transducer are a matched set and must be tested as a set.

a. Connect a variable frequency 120 VAC frequency generator to the AC side of the frequency transducer as shown in figure 6-2.

b. Connect a reference frequency meter across the input. The master frequency meter shall have 5 times the accuracy of the set frequency meter and transducer (1/20 of 1 percent).

c. Vary the frequency from lowest scale reading to full scale reading.

d. The error at any point on frequency meter shall not be greater than 1/4 of 1 percent.

e. Remove test equipment. Replace defective frequency meter and transducer.

6-13. INSTALLATION. Refer to Operator and Organizational Maintenance Manual and install the frequency meter and transducer.

## 6-14. CONTROL BOX RELAY ASSEMBLY (A4).

6-15. TEST ON EQUIPMENT.

a. Symptoms and Isolation of Malfunction. A malfunction of the control box relay assembly (A4) is usually indicated by failure of the generator set to run when the start-run-stop switch (S2) is positioned to RUN or by inability to control voltage from a remote location. To isolate the malfunction proceed as follows:

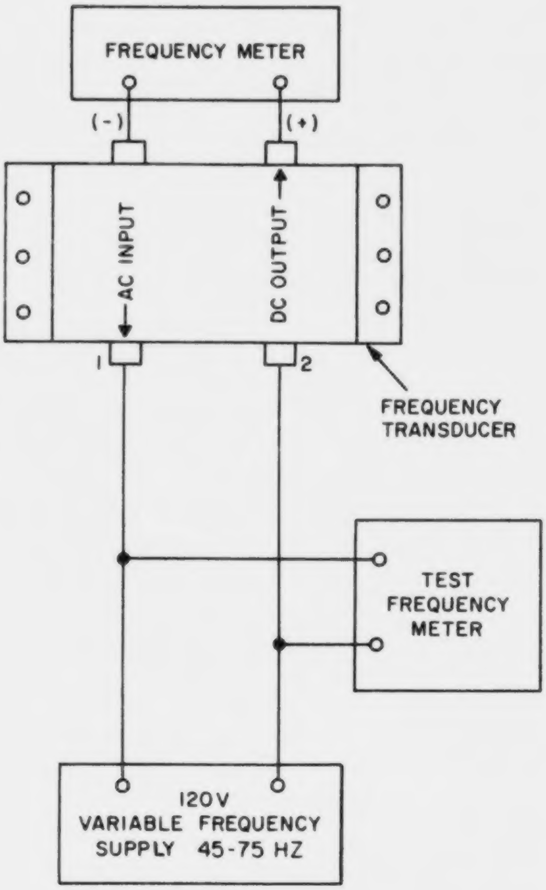


Figure 6-2. Frequency meter (M6) & transducer (A2) test setup

1. Loosen three captive studs and hinge control box door open.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

NOTE

Steps 2. through 7. pertain to stop-run relay K1 and steps 8. through 10. pertain to remote voltage sensing relay K6. All test readings should be ± 20 percent.

2. Energize DC circuit breaker.

3. Start engine. If engine shuts down when start-run-stop switch is positioned to RUN, restart engine and hold switch to START. Measure voltage at relay assembly terminal board across terminals 2 and 8. Voltage should be 24 VDC.

4. If voltage across terminals 2 and 8 is not 24 VDC, shut down generator set. Disconnect wire P50A from terminal 9 and insulate wire end.

5. Restart generator set and measure voltage across terminals 2 and 9. Voltage should be 24 VDC. Connect wire P50A.

6. If voltage across terminals 2 and 9 is not 24 VDC, shut down generator set. Remove wire P80E from terminal 8 and check resistance across terminals 2 and 8. Resistance should be 300 ohms. If not replace stop-run relay K1.

7. If values in steps 2. through 6. are met and circuit is still inoperative, remove control box relay assembly (A4) and bench test.

8. Connect a suitable cable between one of the convenience receptacle outlets (J55) and remote voltage sensing connector (J29). Position convenience receptacle circuit breaker (CB3) OFF. Start engine and position the remote local voltage switch (S5) to the REMOTE position and place convenience receptacle circuit breaker (CB-3) ON. Measure voltage at relay assembly terminal board across terminals 4 and 12, 5 and 11, 6 and 10. Voltage should be 120 VAC nominal.

9. If voltages in step 8. are correct and the remote voltage sensing circuit is still inoperative, shut down generator set. Remove wires X29A and X31A from terminals 4 and 12. Measure resistance at terminals, resistance should be approximately 7K ohms. If not replace remote voltage sensing relay K6.

10. If values in steps 8. and 9. preceding are obtained and circuit is still inoperative, replace control box relay assembly (A4).

b. Removal.

1. Disconnect harness at rear of control cubicle.

2. Loosen three captive studs and hinge open control box door.

3. Tag and disconnect wiring to control box relay assembly terminal boards.

NOTE

The control box relay assembly is mounted inside the control box on the lower center sections of the rear wall.

4. Remove the four nuts located at the back of the rear wall, securing the control box relay to the control cubicle assembly.

## 6-16. TEST.

a. Connect the control box relay assembly to the test equipment as illustrated in figure 6-3.

b. Perform test specified in table 6-1.

NOTE

All voltage values are ± 20 percent.

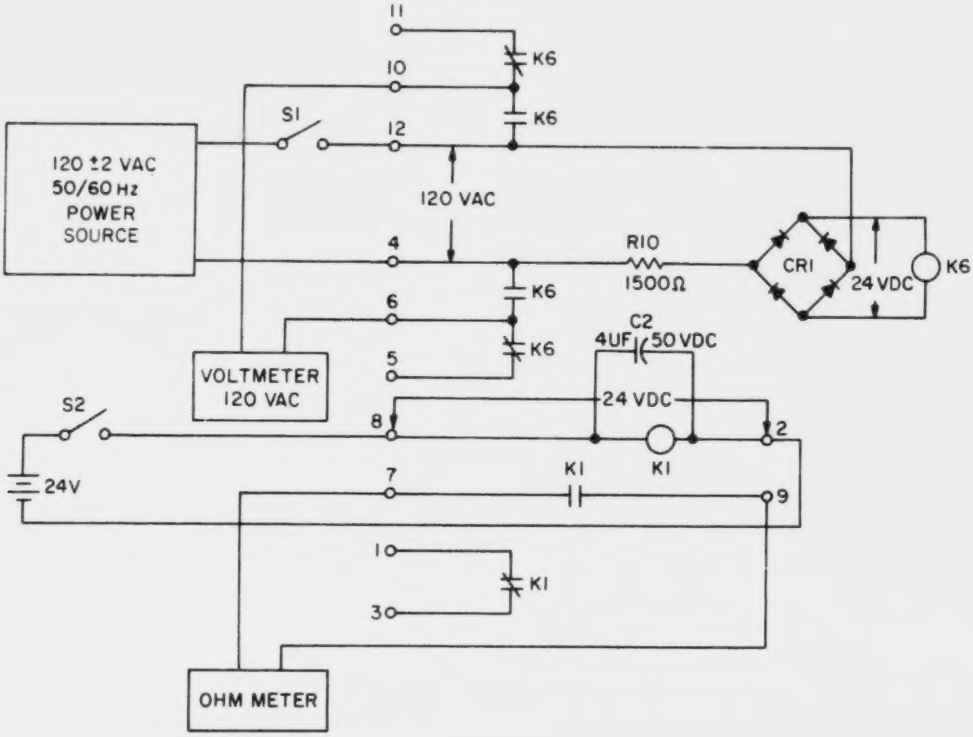

11
10
12
4
6
5
8
7
2
9
1
3
K6
K6
K6
K6
K6
S1
S2
120 ±2 VAC
50/60 Hz
POWER
SOURCE
120 VAC
R10
1500Ω
CR1
24 VDC
C2
4UF
50 VDC
VOLTMETER
120 VAC
24 VDC
24V
K1
K1
K1
OHM METER

Figure 6-3. Control box relay assembly (A4) test setup

## 6-17. DISASSEMBLY.

NOTE

Test control box relay assembly as outlined in paragraph 6-16, then disassemble only to the extent necessary to effect repair.

a. Refer to figure 6-4 and disassemble the control box relay assembly in the order of index numbers assigned.

b. Exercise care when unsoldering components to avoid damage resulting from application of excessive heat

6-18. CLEANING. Clean the control box relay assembly using a clean lint-free cloth, moistened with an approved cleaning solvent and dry thoroughly.

## 6-19. INSPECTION.

a. Inspect terminal boards for cracked insulation, circuit integrity, warping, burned or discolored areas and illegible stenciling.

b. Check forward and reverse resistance of diodes. Measured from anode (+) to cathode (-), value should be low. Reverse leads, value should be infinity.

Table 6-1. Control Box Relay Assembly (A4) Procedural Analysis

<table>
<tr><th>STEP</th><th>TEST CONDITION</th><th>REQUIRED RESULT</th><th>PROBABLE CAUSE FOR IMPROPER RESULT</th><th>CHECK OUT PROCEDURE</th></tr>
<tr><td colspan="5">WARNING<br>Exercise extreme care when applying high voltages as they will cause injury to personnel if they come in contact with them.<br>CAUTION<br>When applying 120 VAC voltages to control box relay assembly terminals, insure correct placement of power supply leads. Damage to other components could result if leads are inadvertently misplaced.</td></tr>
<tr><td rowspan="3">1.</td><td rowspan="3">Apply 120 VAC, 60 Hertz power supply to terminals 4 and 12 of the control box relay assembly. Measure voltage at terminals 6 and 10.</td><td rowspan="3">Voltage measured should be 120 VAC.</td><td>Resistor R10 defective.</td><td>Check resistor with ohmmeter.</td></tr>
<tr><td>Full wave rectifier bridge CR1 defective.</td><td>Check CR1 with ohmmeter.</td></tr>
<tr><td>Defective relay K6.</td><td>Measure dc voltage across relay K6. If voltage is above 18 vdc and improper results still occur;.relay K6 is defective.</td></tr>
<tr><td>2.</td><td>Apply 24 vdc power supply across terminals 2 and 8 of control panel relay assembly. Check continuity across terminals 7 and 9 with ohmmeter.</td><td>There should be continuity across terminals 7 and 9.</td><td>Defective relay K1.</td><td>Replace defective relay.</td></tr>
</table>

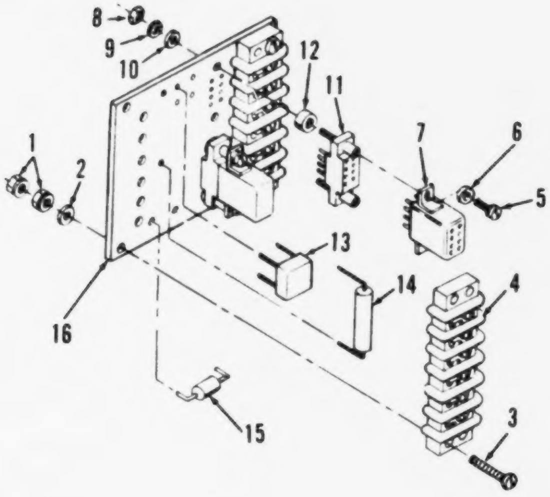


Figure 6-4. Control box relay assembly, exploded view

Legend to figure 6-4:

1. Nut (8)
2. Washer (4)
3. Screw (4)
4. Terminal board (2)
5. Screw (4)
6. Washer (4)
7. Relay (2)
8. Nut (4)
9. Washer (4)
10. Lock washer (4)
11. Relay socket (2)
12. Spacer
13. Silicone bridge rectifier
14. Fixed resistor
15. Capacitor
16. Terminal board

c. Check resistor for proper ohmic value. (15 K ohms.)

d. Check capacitor for opens or shorts.

e. Inspect relay sockets for cracked insulation and broken pin receptacles.

f. Test plug in relays for actuation as illustrated in figure 6-5.

### 6-20. REPAIR.

a. Restencil illegible reference designations.

b. Repair printed circuits by soldering a jumper wire across defective area.

c. Replace all defective components.

d. Solder replacement components using solder conforming to Federal Specification QQ-S-571 Sn 60.

### 6-21. REASSEMBLY.

Refer to figure 6-4 and reassemble control box relay assembly in reverse order of index numbers assigned. Pay particular attention to the following.

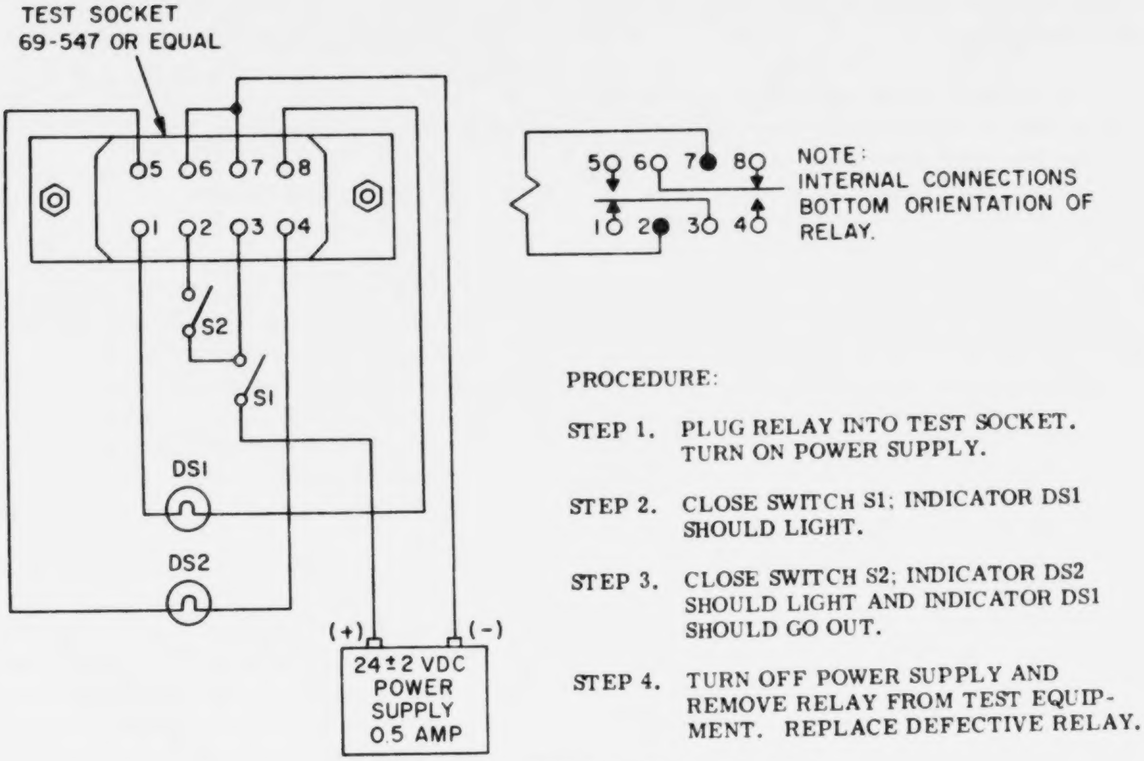
a. When replacing soldered components, use a suitable heat sink. Solder joints and/or component leads shall not project more than 0.094 inch beyond the surface of the board.

b. Spray or brush a conformal coating, 0.005 inch thick, of a transparent dielectric compound corresponding to Specification MIL-I-46058, Grade S, Type PUR to the assembly.

NOTE

The compound shall securely anchor the components to the terminal board. Terminals for connection to external circuits shall not be coated.

c. Test control box relay assembly as outlined in paragraph 6-16.


TEST SOCKET
69-547 OR EQUAL
5
6
7
8
1
2
3
4
S2
S1
DS1
DS2
(+)
(-)
24±2 VDC
POWER
SUPPLY
0.5 AMP
5
6
7
8
1
2
3
4
NOTE:
INTERNAL CONNECTIONS
BOTTOM ORIENTATION OF
RELAY.

PROCEDURE:

STEP 1. PLUG RELAY INTO TEST SOCKET. TURN ON POWER SUPPLY.

STEP 2. CLOSE SWITCH S1; INDICATOR DS1 SHOULD LIGHT.

STEP 3. CLOSE SWITCH S2; INDICATOR DS2 SHOULD LIGHT AND INDICATOR DS1 SHOULD GO OUT.

STEP 4. TURN OFF POWER SUPPLY AND REMOVE RELAY FROM TEST EQUIPMENT. REPLACE DEFECTIVE RELAY.

Figure 6-5. Plug in relay test setup

## 6-22. INSTALLATION.

a. Position the control box relay assembly inside the control cubicle and secure it to the rear wall with four nuts.

b. Connect wiring to the control box relay assembly terminal boards. Refer to figure 1-5 and check wires for proper connection.

c. Close and secure control box door.

d. Connect harness at rear of control cubicle.

## 6-23. AC CURRENT METER (M8).

## 6-24. TEST ON EQUIPMENT.

a. Symptoms and Isolation of Malfunction. A malfunction of the AC current meter is usually indicated by abnormal readings when a known load is connected to the generator set. To isolate the malfunction proceed as follows:

1. Loosen three captive studs and hinge control box door open.

2. Connect suitable test ammeter in series with AC current meter.

3. Start generator set and apply full rated load.

4. Check meter indication, AC current meter should indicate 100 percent and test ammeter should indicate 0.75 amperes. Check indication at each phase by rotating voltmeter-ammeter selector switch (S8), readings should be the same.

5. If current reading is incorrect check wiring back to current source.

6. If current is correct remove AC current meter.

b. Removal. Refer to Operator and Organizational Maintenance Manual and remove the AC current meter.

6-25. CLEANING. Clean the AC current meter using a clean, lint-free cloth, moistened with an approved cleaning solvent and dry thoroughly.

6-26. INSPECTION. Inspect case for evidence of cracks or tears and electrical connector for security.

6-27. TEST. Connect the AC current meter to the test equipment as illustrated in figure 6-6 and proceed as follows:

a. Adjust auto-transformer T1 so that ammeter M1 reads 1 ampere. AC current meter should indicate 133 percent load.

b. Adjust auto-transformer T1 so that meter M1 reads 0.75 ampere. AC current meter should indicate 100 percent load.

c. Remove test equipment. Replace AC current meter if meter error is greater than 2 percent of full scale value.

6-28. INSTALLATION. Refer to Operator and Organizational Maintenance Manual and install the AC current meter.

## 6-29. CONTROL CUBICLE.

6-30. TEST ON EQUIPMENT.

a. Symptoms and Isolation of Malfunction. A malfunction of the control cubicle is usually indicated by the conditions described and isolated in paragraphs 6-3, 6-9, 6-15 and 6-24. If a malfunction exists which is not traceable to those assemblies, perform a continuity check on the wires comprising the control cubicle assembly harness.

b. Removal. Refer to paragraph 2-6 and figure 2-2 and remove the control cubicle assembly.

6-31. DISASSEMBLY. Refer to figure 6-7 and disassemble control cubicle assembly in the order of index numbers assigned. Pay particular attention to the following:

a. Loosen three captive studs (23) and hinge open control box door (25).

b. Tag and disconnect wires of harness (15) from components.

c. Refer to Operator and Organizational Maintenance Manual and remove components from control box door (25), and the thermal watt converter and frequency transducer from the box (36).

d. Remove the control box relay from the rear wall of box (36).

e. Hinge (32) and receptacle (35) are riveted to box (36) and should be removed only if damaged.

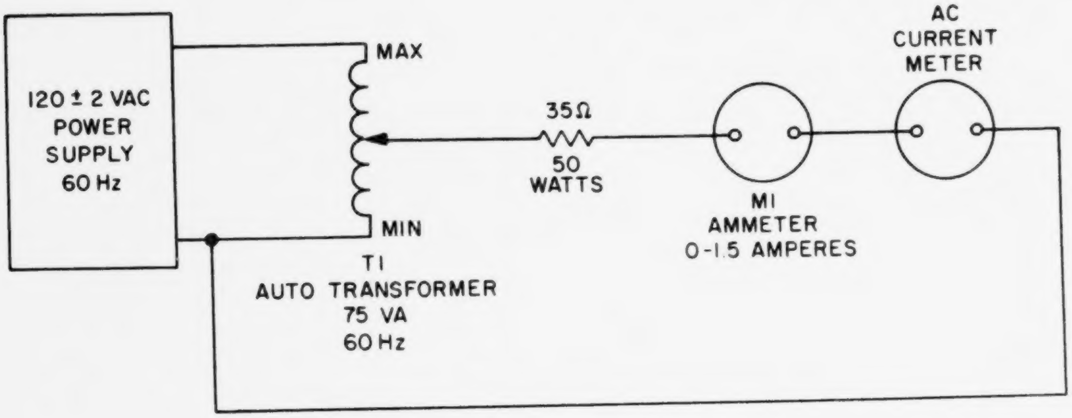


Figure 6-6. AC current meter (M8) test setup

## 6-32. CLEANING.

[illegible] electrical components and instrum[illegible] with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

b. Clean metal parts in an approved cleaning solvent and dry thoroughly.

## 6-33. INSPECTION.

NOTE

Figure 1-4 is the schematic for the control cubicle.

a. Inspect meters and gauges for damaged cases and faces.

b. Check switches for continuity.

c. Inspect terminal boards for cracked insulation, stripped threads, and missing jumper strips.

d. Check capacitors for opens and shorts.

e. Check resistor for continuity and proper ohmic values.

f. Check rheostats for continuity and for proper adjustable range of resistance.

g. Inspect terminal lugs for security and condition.

h. Inspect wiring for defective insulation and electrical connectors for damaged threads; bent, loose, or missing pins. Check each harness wire from connector pin to wire end for continuity, refer to figure 6-8. Check connector pins for shorts to case and surrounding pins.

i. Inspect sheet metal parts for bent corners, distortion, cracks, tears, and dents.

## 6-34. REPAIR.

a. Straighten dents or distorted areas of the box using proper tools.

b. Minor cracks may be repaired by welding.

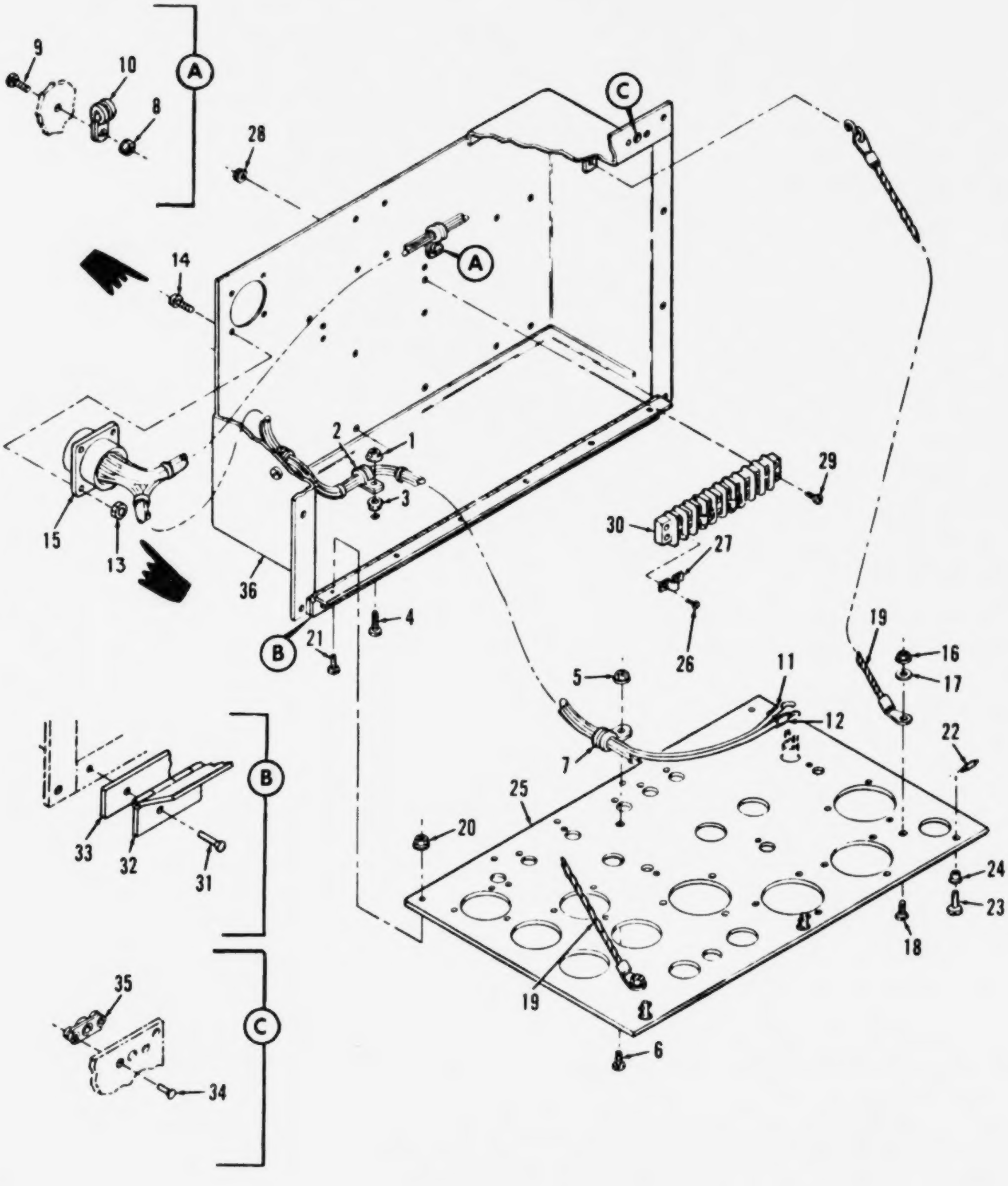

9
10
A
8
28
C
14
A
2
1
29
3
15
13
30
27
36
4
B
21
26
19
16
17
5
11
12
7
22
25
20
24
23
18
19
6
B
33
32
31
35
C
34

Figure 6-7. Control cubicle exploded view

Legend to figure 6-7:

1. Nut (2)
2. Clamp (2)
3. Nut (2)
4. Screw (2)
5. Nut
6. Screw
7. Clamp
8. Nut
9. Screw
10. Clamp
11. Insulator (3)
12. Insulator (3)
13. Nut (4)
14. Screw (4)
15. Harness
16. Nut (2)
17. Washer (2)
18. Screw (2)
19. Door holder (2)
20. Nut (6)
21. Screw (6)
22. Cross pin (3)
23. Stud (3)
24. Grommet (3)
25. Control box door
26. Screw (6)
27. Terminal board jumper (3)
28. Nut (2)
29. Screw (2)
30. Terminal board
31. Rivet (6)
32. Hinge
33. Spacer
34. Rivet (6)
35. Receptacle (3)
36. Box

c. Repaired areas and those surfaces requiring refinishing shall be cleaned with a suitable abrasive paper, then primed and repainted.

d. Re-stencil as required.

6-35. REBUILD. Rebuild the control cubicle wire harness (15, figure 6-7) according to figure 6-8.

6-36. REASSEMBLY. Refer to figure 6-7 and reassemble control cubicle assembly in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Install control box relay on rear wall of box (36). Secure in position with four nuts.

b. Refer to Operator and Organizational Maintenance Manual and install components on control box door (25), and thermal watt converter and frequency transducer in box (36).

c. Install harness (15) connector in box (36) with key way on top. Connect wires of harness to components, refer to figure 1-5.

d. When installing clamp (2, figure 6-7) nearest control box door (25), leave nut (1) loose enough to permit harness to pivot when control box door is opened and closed.

6-37. TEST. Refer to figure 1-5 and perform continuity test of circuitry.

6-38. INSTALLATION. Refer to paragraph 2-6 and figure 2-2 and install the control cubicle assembly.

6-39. ADJUSTMENT. Refer to Operator and Organizational Maintenance Manual and zero adjust all instruments.

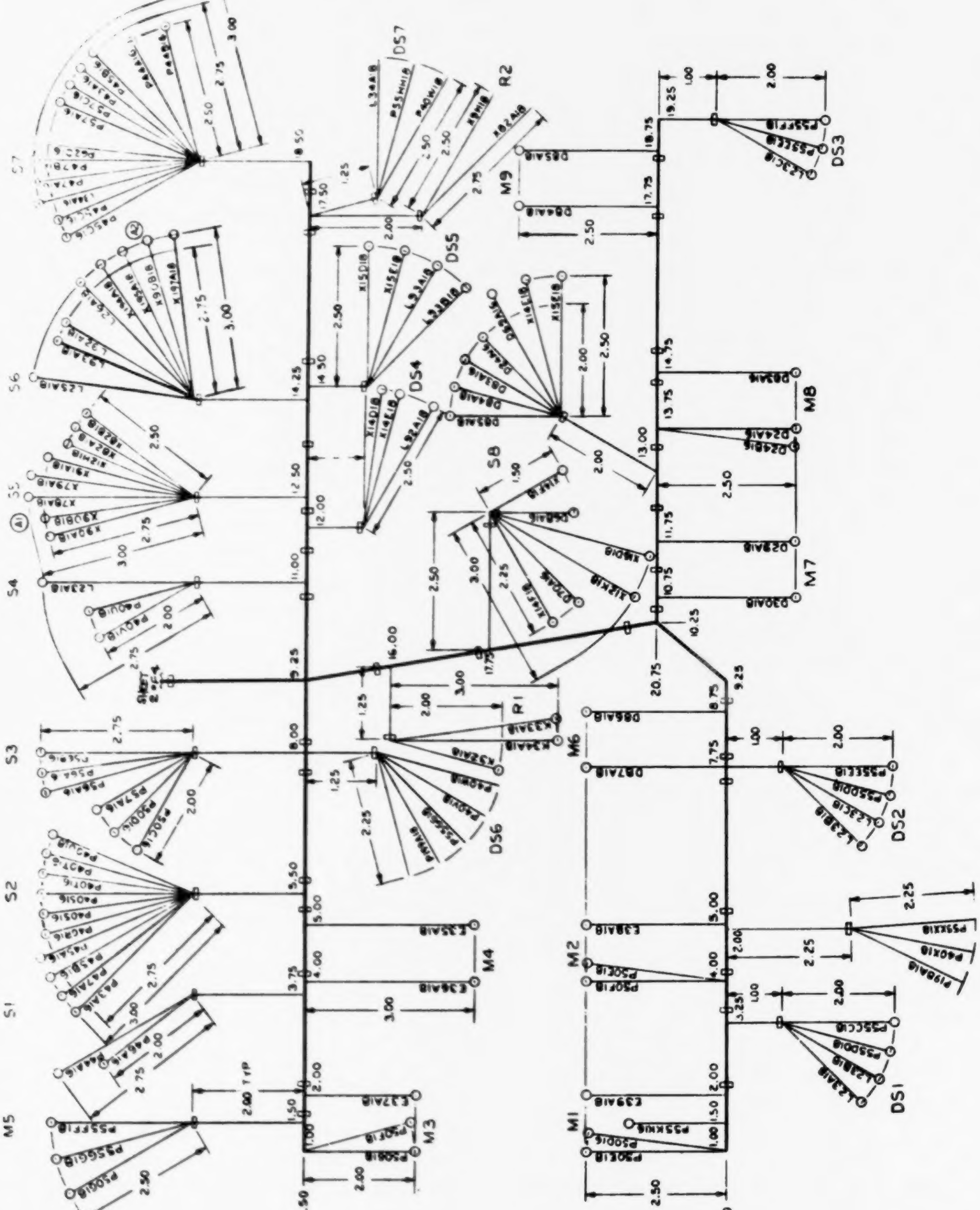

M5
S1
S2
S3
S4
S5
S6
S7
DS7
R2
DS5
DS4
S8
R1
DS6
M3
M4
M1
M2
M6
M7
M8
M9
DS1
DS2
DS3
DS8
SHEET 2 FIG 4
14.50
22.00

Figure 6-8. Control cubicle wire harness (Sheet 1 of 4)

| WIRE MARKING NO | FROM | | TO | | WIRE FIND NO | CUT LENGTH IN | MARKING COLOR |
|---|---|---|---|---|---|---|---|
| | STATION NO | LUG FIND NO | STATION NO | LUG FIND NO | | | |
| X9H18 | TB1-7 | 5 | R2-L | 1 4 STRIP | 2 | 43 | BLACK |
| X12D16 | J1-y | — | TB1-1 | 11 | 1 | 9 | |
| X12E18 | A2-1 | 4 | TB1-1 | 5 | 2 | 10 | |
| X12G18 | TB1-1 | 5 | A4-5 | 5 | 2 | 7 5 | |
| X12H18 | TB1-1 | 5 | S5-4 | 4 | 2 | 36 | |
| X12J18 | TB1-2 | 5 | A1-N3 | 4 | 2 | 15 | |
| X12K18 | TB1-2 | 5 | S8-17 | 4 | 2 | 38 | |
| X12L18 | A1-N1 | 4 | A1-N2 | 4 | 2 | 5 5 | |
| X12M18 | A1-N2 | 4 | A1-N3 | 4 | 2 | 5 5 | |
| X14D18 | J1-G | — | DS4-1 | 4 | 2 | 31 | |
| X14E18 | S8-12 | 4 | DS4-1 | 4 | 2 | 18 | |
| X14F18 | S8-12 | 4 | S8-24 | 4 | 2 | 4 5 | |
| X15D18 | J1-H | — | DS5-1 | 4 | 2 | 33 5 | |
| X15E18 | S8-22 | 4 | DS5-1 | 4 | 2 | 20 | |
| X16D18 | J1-I | — | S8-13 | 4 | 2 | 34 | |
| X29A18 | J1-S | — | A4-12 | 5 | 2 | 23 | |
| X31A18 | J1-0 | — | A4-4 | 5 | 2 | 14 | |
| X78A18 | A4-10 | 5 | S5-3 | 4 | 2 | 51 5 | |
| X79A18 | A4-6 | 5 | S5-6 | 4 | 2 | 40 | |
| X82A18 | S5-1 | 4 | R2-M | 5 8 STRIP | 2 | 14 | |
| X82B18 | A4-11 | 5 | S5-1 | 4 | 2 | 50 | |
| X90A18 | J1-U | — | S5-2 | 4 | 2 | 32 | |
| X90B18 | S6-7 | 4 | S5-2 | 4 | 2 | 11 5 | ↓ |
| X91A18 | J1-L | — | S5-5 | 4 | 2 | 32 5 | |
| X7D18 | J1-E | — | A1-V1 | 4 | 2 | 23 5 | BLACK |
| X8D18 | J1-F | — | A1-V2 | 4 | 2 | 23 5 | |
| X9D16 | J1-z | — | TB1-6 | 11 | 1 | 12 | |
| X9F18 | TB1-7 | 5 | A1-V3 | 4 | 2 | 12 | |
| X9G18 | A2-2 | 4 | TB1-6 | 5 | 2 | 12 5 | |
| X194A18 | J1-P | — | S6-11 | 4 | 2 | 36 | |
| X195A18 | J1-f | — | S6-10 | 4 | 2 | 36 | |
| | | | | | | | |
| X197A18 | J1-n | — | S6-8 | 4 | 2 | 36 | ↓ |

| FIND NO | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|---|
| 13 | CLASS I | 12⅛ in | INSULATION TUBING ELECTRICAL HEAT SHRINKABLE BLACK 187 DIA | MIL-I-23053 |
| 12 | 69-661-14 | 1 | CONNECTOR RECEPTACLE ELECTRICAL | |
| 11 | MS25036-153 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I NO 9 STUD SIZE NO 16-14 W SIZE | |
| 10 | MS25036-154 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I 1 4 STUD SIZE NO 16-14 W SIZE | |
| 9 | MS25036-108 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I NO 10 STUD SIZE NO 16-14 W SIZE | |
| 8 | MS25036-106 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I NO 6 STUD SIZE NO 16-14 W SIZE | |
| 7 | MS25036-150 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I 1 4 STUD SIZE NO 22-18 W SIZE | |
| 6 | MS25036-103 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I NO 10 STUD SIZE NO 22-18 W SIZE | |
| 5 | MS25036-149 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I NO 8 STUD SIZE NO 22-18 W SIZE | |
| 4 | MS25036-102 | | TERMINAL LUG CRIMP STYLE COPPER INS CLASS I NO 6 STUD SIZE NO 22-18 W SIZE | |
| 3 | MS18034-1-2 | | STRAP CABLE ADJUSTABLE SELF-CLINCHING PLASTIC TYPE I CLASS I | |
| 2 | M5086 2-18-9 | AR | WIRE ELECTRICAL 600-VOLT COPPER AIRCRAFT NO AN-18 | MIL-W-5086/2 |
| 1 | M5086 2-16-9 | AR | WIRE ELECTRICAL 600-VOLT COPPER AIRCRAFT NO AN-16 | MIL-W-5086/2 |

NOTES

1 CONTACT PINS ARE SUPPLIED WITH CONNECTOR (ITEM 12) AND SHALL BE USED IN THEIR RESPECTIVE HOLES

2 CUT INSULATION TUBING (ITEM 13) INTO 39 PIECES 375 LONG AND INSTALL AROUND WIRES AND PINS ATTACHED TO THE CONNECTOR (ITEM 12) THEN APPLY HEAT OF 400° F FOR 3-5 SEC FOR PROPER SHRINKAGE

3 WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5086 PARA 3 9 3 & 3 9 3 1 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES

Figure 6-8. Control cubicle wire harness (Sheet 4 of 4)

## Section II. DC CIRCUIT BREAKER BOX

### 6-40. GENERAL.

The dc circuit breaker box is located at the rear of the generator set to the right of the control cubicle assembly panel. The circuit breaker box contains a 7.5 ampere circuit breaker CB1, associated wiring, and a connector for electrical connection to the generator set dc system. Circuit breaker CB1 is electrically connected between the batteries and the START-RUN-STOP switch S2 in the dc system. It protects all control circuits energized from the batteries except those for the winterization heater and dc alternator. In the close position the pushbutton only shows black. When tripped, the button is extended and the white portion is visible.

### 6-41. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove dc circuit breaker box.

### 6-42. DISASSEMBLY.

Refer to figure 6-9 and disassemble dc circuit breaker box in the order of index numbers assigned. Pay particular attention to the following:

a. Remove screws (1) and separate cover (6) and chassis (10) so that wires can be disconnected from circuit breaker (9).

b. Tag and disconnect electrical wiring from circuit breaker.

### 6-43. CLEANING.

Clean parts with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

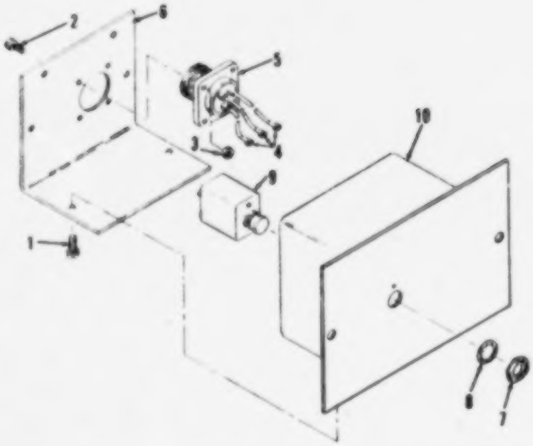


Figure 6-9. DC circuit breaker box, exploded view

Legend to figure 6-9:

1. Screw assembly (4)
2. Screw assembly (4)
3. Nut assembly (4)
4. Terminal lug (3)
5. Connector
6. Cover
7. Nut
8. Washer
9. Circuit breaker
10. Chassis

### 6-44. INSPECTION.

Inspect dc circuit breaker box components as follows:

a. Inspect sheet metal parts for dents, cracks, and distortion.

b. Inspect connector for bent, broken, and missing pins. Refer to table 6-2 and test wires and connector for continuity,

Table 6-2. Circuit Breaker Box Hookup Wire Data

| WIRE IDENT. NO. | FROM | TERMINATION NOTE | TO | TERMINATION NOTE | WIRE LENGTH (INCHES) |
|---|---|---|---|---|---|
| P40 | J39-A | 1, 4, 5 | CB1-2 | 2 | 4 |
| P141 | J39-B | 1, 4, 5 | CB1-1 | 2 | 4 |
| P141 | J39-C | 1, 4, 5 | CB1-1 | 2 | 4 |

NOTES

1. Solder, use Federal Specification QQ-S-571, Sn 60.
2. Secure end with terminal lugs, MS25036-156.
3. Wire is M50862-12-9 per MIL-W-5086.
4. Use 5/8 inch long insulation tubing over each contact after soldering.
5. Insulation is TYPE F FORM Va, GRADE A, CLASS 1, CATA-1 per MIL-I-631.

shorts to case and surrounding pins. Check terminal lugs for condition and security.

c. Check circuit breaker automatic tripping with load application above 7.5 ampere.

6-45. REPAIR.

Repair defective wiring in accordance with table 6-2.

6-46. REASSEMBLY.

Refer to figure 6-9 and reassemble dc circuit breaker box in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Install connector (5) with keyway up.

6-47. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install DC circuit breaker box.

## Section III. FAULT LOCATING INDICATOR BOX

### 6-48. GENERAL.

The fault locating indicator box (A9) is a self-contained unit with solid state circuitry. On its front panel are ten red malfunction indicators, each for a specific fault, a one ampere fuse to protect against overload, and a two pole, two position, spring loaded switch. The function of the indicator box is to illuminate a particular malfunction indicator when one of the protective devices senses a malfunction and closes its malfunction signal contacts. This causes a dc signal to be impressed across a series parallel RC network for one of the ten SCR, silicon controlled rectifier, circuits in the fault locating indicator box (refer to figure 1-6). When the voltage across the capacitor is sufficient, the current to the gate of the SCR will be sufficient to trigger it. The particular indicator lamp in series with this SCR will be energized. Relay K1 is also energized and its normally closed contacts open to deenergize the fault signal input to the SCR. When the switch is momentarily positioned to TEST or RESET, the SCR will be turned off because its negative return from cathode is open. All indicator lamps will be energized, and relay K1 will stay energized. When the switch is released back to normal position, and if the fault is cleared, the indicator lights will de-energize and the circuit will be quiescient. If the malfunction is still present the SCR and indicator lamp for that particular malfunction will again energize. With no malfunction input and the switch momentarily positioned to TEST or RESET, all indicator lamps will energize. With its release again, all lamps will be de-energized and the circuit is again quiescent. The purpose of capacitor C11 is to block transient d.c. voltage and frequency chatter from causing a false malfunction indication.

### 6-49. TEST ON EQUIPMENT.

a. Symptom and Isolation of Malfunction. A malfunction of the fault locating indicator box is usually the absence of a fault indication during a fault condition. Another malfunction is a false indication which cannot be reset when a no fault condition exists. To isolate the malfunctions proceed as follows:

NOTE

Refer to figures 1-6 and 1-7 for circuitry, and component layout and wiring.

1. No Indication.

(a) Press the switch S1 to TEST OR RESET, all the indicator lights DS1 through DS10 should illuminate.

(b) Check for defective indicator lamp if one or two do not illuminate.

(c) If no lamp illuminates check fuse F1.

(d) If fuse F1 is not defective remove plug P12 and check pins A(+) and B(-) for 24 VDC.

(e) With the above requirements met and indicators not illuminating, check wiring to fault sensor. For example high coolant pins C-K on connector P12 with fault simulated should have continuity. Reconnect P12 and simulate a high coolant fault if indicator lamp DS7 does not illuminate, repair or replace the fault indicator box. Similar tests procedure will apply to remaining faults.

2. False Fault Indication Cannot Be Reset.

(a) Remove P12 and check for continuity from pin C to applicable pin of P12 for the circuit showing false indication. Open circuit should be indicated.

(b) If circuit is open, remove, repair or replace the fault indicator box.

b. Removal. To remove the fault locating indicator box (located adjacent to control cubicle), disconnect plug P12 from the receptacle connector (J12) in the rear wall of the box, then remove the four screws securing the box to the rear housing.

## 6-50. TEST.

Connect the fault locator to test equipment as illustrated in figure 6-10 and perform test specified in procedural analysis table 6-3.

NOTE

Figure 1-6 is the fault locating indicator box schematic. Refer to this schematic when checking individual components for their required values or operating characteristics.

## 6-51. DISASSEMBLY.

Refer to figure 6-11 and disassemble fault locating indicator box in the order of index numbers assigned. Pay particular attention to the following:

NOTE

Disassemble the fault locating indicator box only to the extent necessary to accomplish repair.

a. Remove cover (2) by removing screws (1).

b. Tag and disconnect wires of harness (19) from components.

c. Exercise care not to apply excessive heat when unsoldering components.

d. Remove relay (22) by removing screw (20) and lockwasher (21).

## 6-52. CLEANING.

Clean all components with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

## 6-53. INSPECTION.

a. Harness.

1. Inspect harness wiring for defective insulation and continuity.

2. Inspect harness connector for damaged threads; bent, loose or missing pins and for shorts.

b. Electrical Components.

1. Check electrical components for opens, shorts, continuity, and proper values.

2. Check diodes for forward and reverse values. Measured from anode (+) to cathode (-) value should be low. Reverse leads, value should be infinity.

c. Printed Circuit Board.

1. Inspect printed circuit boards (component side) for damage, burns, discolored areas, and signs of overheating.

2. Inspect components for security.

3. Inspect circuits of printed circuit boards for breaks and damage.

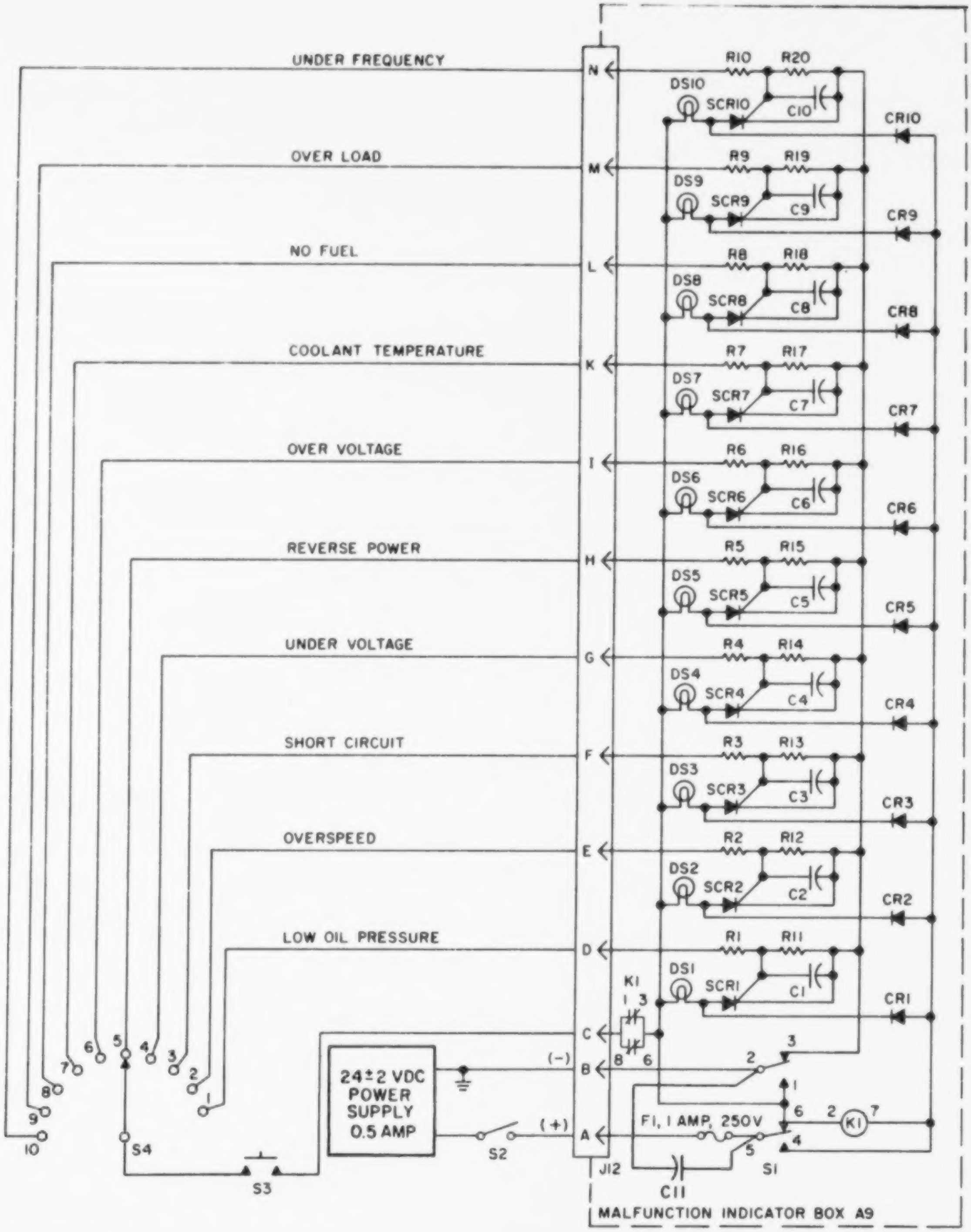

UNDER FREQUENCY
OVER LOAD
NO FUEL
COOLANT TEMPERATURE
OVER VOLTAGE
REVERSE POWER
UNDER VOLTAGE
SHORT CIRCUIT
OVERSPEED
LOW OIL PRESSURE
N
M
L
K
I
H
G
F
E
D
C
B
A
J12
R10
R20
DS10
SCR10
C10
CR10
R9
R19
DS9
SCR9
C9
CR9
R8
R18
DS8
SCR8
C8
CR8
R7
R17
DS7
SCR7
C7
CR7
R6
R16
DS6
SCR6
C6
CR6
R5
R15
DS5
SCR5
C5
CR5
R4
R14
DS4
SCR4
C4
CR4
R3
R13
DS3
SCR3
C3
CR3
R2
R12
DS2
SCR2
C2
CR2
R1
R11
DS1
SCR1
C1
CR1
K1
1 3
8 6
24±2 VDC POWER SUPPLY 0.5 AMP
(−)
(+)
S2
S3
S4
10
9
8
7
6
5
4
3
2
1
F1, 1 AMP, 250V
K1
S1
C11
MALFUNCTION INDICATOR BOX A9

Figure 6-10. Fault locating indicator box (A9), test setup

Table 6-3. Fault Locating Indicator Box (A9) Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 1. | **With switch S2 open, energize the 24 vdc power supply. Close switch S2 and leave switch S1 in the normal spring maintained position.** | None of the fault locator indicators should energize. | Shorted or defective switch S1 on fault locator box. | Check continuity with ohmmeter between terminals 2 and 1, and 4 and 5 of switch S1. There should be no continuity. |
| | | | Shorted or defective silicon controlled rectifier SCR1 through SCR10. | Measure voltage at anode of SCR in particular indicator circuit which was energized. If voltage is less than 24 volts, the SCR is defective. |
| 2. | Rotate switch S4 to position 1 and momentarily depress switch S3. Momentarily depress switch S1 to TEST OR RESET. Repeat this procedure for each position of switch S4. | The particular indicator (DS1 through DS10) for particular position of S4 should energize after momentarily depressing S3. It should then deenergize after momentarily depressing S1 to TEST OR RESET. | Defective switch S1 . | Check continuity of switch. |
| | | | Relay K1 contacts open or defective. | Check relay K1 in accordance with figure 6-5. |
| | | | Defective components in gate bias circuit of particular SCR circuit. | Check applicable resistors R1 through R20, and capacitors C1 through C10. |

Table 6-3. Fault Locating Indicator Box (A9) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE OR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 2. (cont) | Rotate switch S4 to position 1 and momentarily depress switch S3. Momentarily depress switch S1 to TEST OR RESET. Repeat this procedure for each position of switch S4. (continued) | The particular indicator (DS1 through DS10) for particular position of S4 should energize after momentarily depressing S3. It should then deenergize after momentarily depressing S1 to TEST OR RESET (continued) | Defective silicon controlled rectifier (SCR1 through SCR10). | Measure voltage across anode and cathode of particular SCR for indicator circuit that had improper test results with S3 depressed and held. If voltage is 24 vdc, and gate to cathode voltage is present (approx. 1 vdc), SCR is defective. |
| | | | Defective indicator lamp (DS1 through DS10). | Check lamps by applying 24 vdc. |
| | | | Fuse F1 is defective. | Check continuity of fuse. |
| 3. | Position switch S1 to TEST OR RESET and hold | All of the indicator lights DS1 through DS10 should be energized when S1 is held to TEST OR RESET. | Defective indicator lamps. | Check lamps. |
| | | | Defective switch S1. | Check continuity of switch S1. |
| | | | Defective diodes CR1 through CR10. | Check diodes by measuring voltage across diode while S1 is in TEST OR RESET position. The voltage should be less than 1 vdc. |

4. Inspect base of printed circuit board for cracks, warping, burned or discolored areas and illegible stenciling.

d. Inspect sheet metal parts for bent corners, distortion, cracks, tears and dents.

e. Check terminal lugs for security and condition.

f. Inspect relay socket for damage, shorts to case, and surrounding pins.

g. Inspect for damaged indicator lenses.

h. Check fuse for continuity.

### 6-54. REPAIR.

a. Repair or fabricate fault locating indicator box wiring harness according to figure 6-12.

b. Repair or fabricate fault locating indicator box heating wire in accordance with table 6-4.

c. Replace indicator lenses, if cracked.

d. Replace fuse if defective.

e. When replacing feed thru terminals, swage in place.

f. Repair circuit board as follows:

1. Restencil all illegible reference designations.

CAUTION

Prolonged use of soldering equipment could cause damage to components due to excessive heat.

2. Replace all defective components.

3. Solder replacement components on the printed circuit boards using solder conforming to Federal Specification QQ-S-571 Sn 60.

4. Solder joints and/or component leads must not project more than 0.094 inch (2.388 mm) beyond surface of board.

5. After replacement of components on the circuit board, coat the board with protective coating, conforming to Military Specification MIL-I-46058, grade S, type PUR, 0.005 inch (0.127 mm) minimum thickness. Air bubbles should be prevented during coating so that legibility of identification or information markings are not impaired. The coating shall be applied so that it anchors the components to the board. Terminals utilized for connection to external circuits shall not be coated.

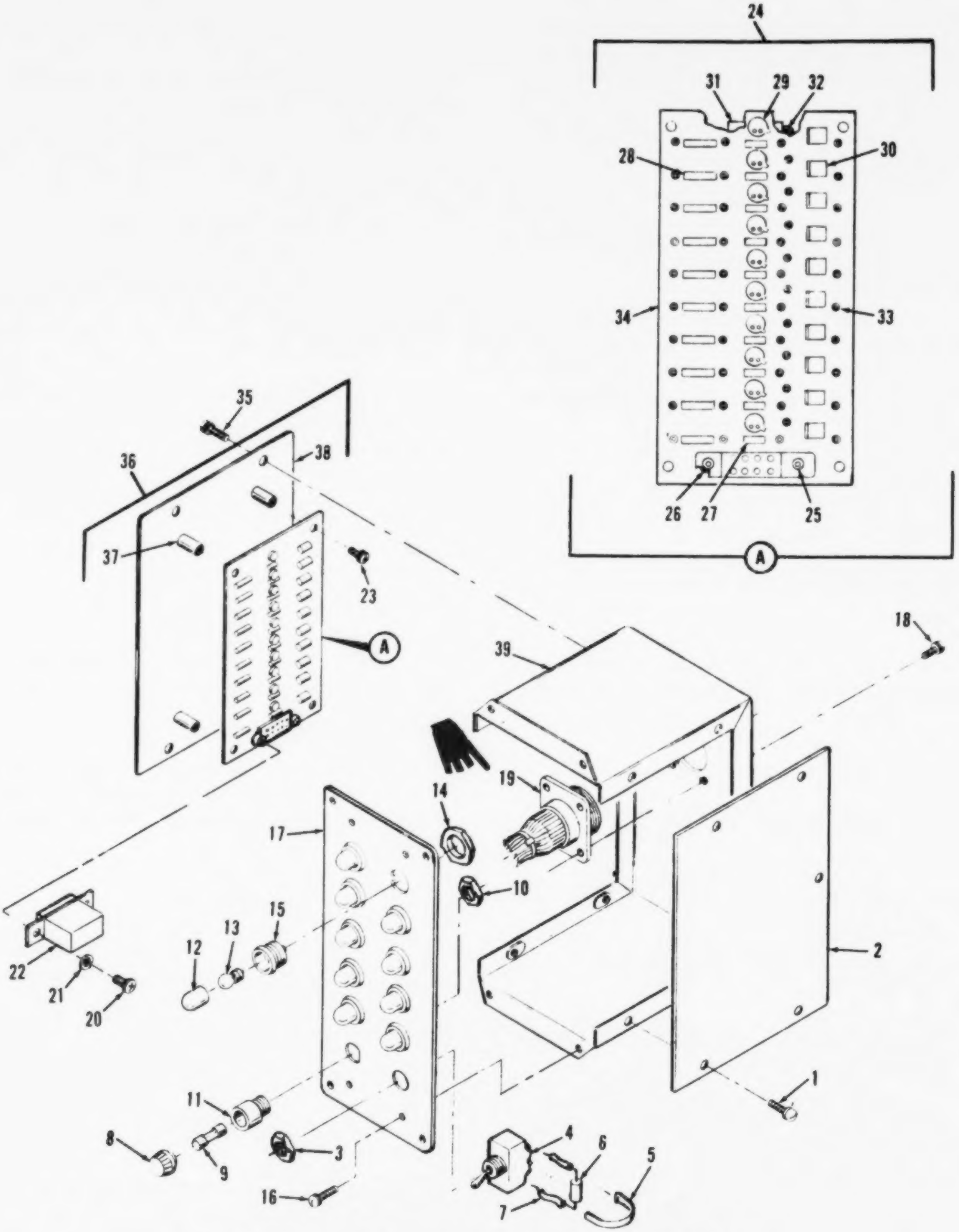
g. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with suitable abrasive paper. Prime and touch up damaged painted surfaces.

### 6-55. REASSEMBLY.

Refer to figure 6-11 and reassemble fault locating indicator box in the reverse order of index numbers assigned. Pay particular attention to the following:

NOTE

Mount connector (J12) with keyway in top position.


24
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1
16
7

Figure 6-11. Fault locating indicator box, exploded view

Legend to figure 6-11:

1. Screw (5)
2. Cover
3. Nut
4. Toggle switch
5. Strap (2)
6. Capacitor
7. Insulation (2)
8. Fusecap
9. Fuse
10. Nut
11. Fuseholder
12. Indicator lenses (10)
13. Incandescent lamp (10)
14. Nut (10)
15. Light indicator housing (10)
16. Screw (4)
17. Fault indicator panel
18. Screw (4)
19. Wiring harness
20. Screw (2)
21. Washer (2)
22. Relay
23. Screw (4)
24. Fault indicator component board
25. Relay socket
26. Standoff
27. Resistor (10)
28. Resistor (10)
29. Silicon controlled rectifier (10)
30. Silicon rectifier (10)
31. Capacitor (10)
32. Insulation
33. Terminal stud (50)
34. Board
35. Screw (4)
36. Bottom plate
37. Standoff (4)
38. Plate
39. Chassis

a. Connect hookup wires and wires of harness to components. Refer to tables 6-4 and figures 6-12 and 1-7 for proper connection.

b. Exercise care not to apply excessive heat to components when soldering connections.

c. Install relay (22, figure 6-11) in relay socket (25) squarely so as not to damage pins.

d. Test fault locating indicator box as specified in paragraph 6-50.

e. Install cover (2) by installing screws (1).

## 6-56. INSTALLATION.

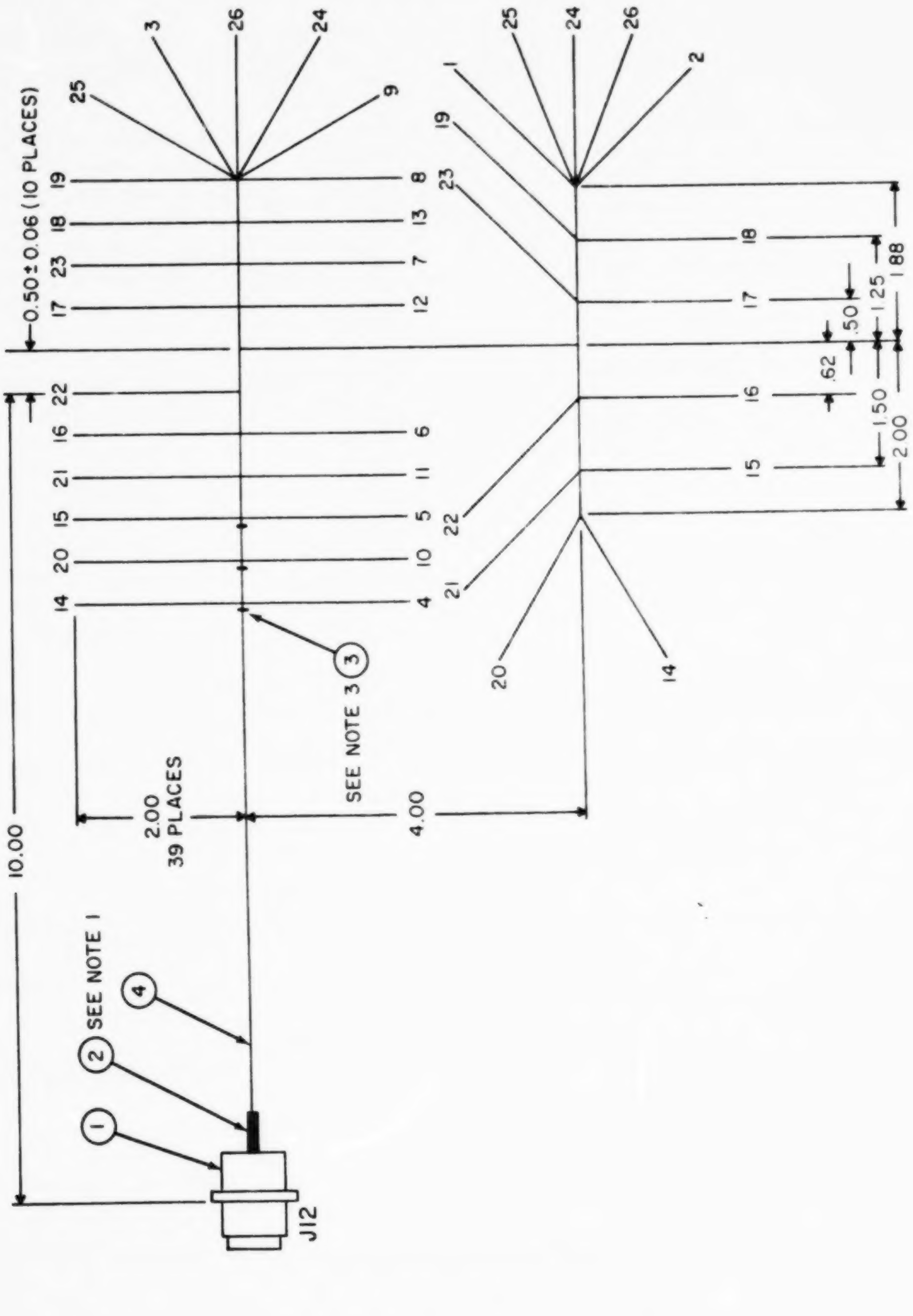
Install the fault locating indicator box in the rear housing and secure in position with four screws. Connect plug P12 to receptacle connector J12 located in the rear wall of the box.

Table 6-4. Fault Locating Indicator (A9) Hook Up Wire Data

| COLOR | WIRE | WIRE LENGTH INCHES (MM) | FROM | TO |
|---|---|---|---|---|
| WHT | 27 | 1-1/2 (38.1) | S1-1 | S1-6 |
| WHT | 28 | 2-1/2 (63.5) | S1-6 | XDS6 |
| WHT | 29 | 1-1/4 (31.75) | XDS6 | XDS10 |
| WHT | 30 | 1-1/4 (31.75) | XDS10 | XDS9 |
| WHT | 31 | 1-1/4 (31.75) | XDS9 | XDS8 |
| WHT | 32 | 1-1/4 (31.75) | XDS8 | XDS7 |
| WHT | 33 | 1-1/4 (31.75) | XDS7 | XDS1 |
| WHT | 34 | 1-1/4 (31.75) | XDS1 | XDS2 |
| WHT | 35 | 1-1/4 (31.75) | XDS2 | XDS3 |
| WHT | 36 | 1-1/4 (31.75) | XDS3 | XDS4 |
| WHT | 37 | 1-1/4 (31.75) | XDS4 | XDS5 |
| WHT | 38 | 3/4 (19.05) | S1-5 | XF1 |
| WHT | 39 | 3/4 (19.05) | XK1-8 | XK1-1 |
| WHT | 40 | 1 (25.40) | XK1-6 | XK1-2 |
| WHT | 41 | 1/2 (12.70) | XK1-3 | XK1-2 |
| WHT | 42 | 1-1/2 (38.1) | XK1-7 | TB1-50 |

NOTES

1. Solder. Use Federal Specification QQ-S-571, Sn 60.
2. Wire is in accordance with MIL-STD-454, requirement 20.
3. Use wire conforming to MIL-W-16878, Type 22 black or white.
4. Protect capacitor C11 leads using insulated sleeving.


0.50±0.06 (10 PLACES)
10.00
2.00
39 PLACES
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SEE NOTE 1
SEE NOTE 3
①
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J12
.62
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2

Figure 6-12. Fault locating indicating box wiring harness (Sheet 1 of 2)

| WIRE NO. | TERMINATION | | | WIRE FIND NO. |
|---|---|---|---|---|
| | FROM | FIND NO. | TO | |
| 1 | J12-A | 1 | XF1 | 4 |
| 2 | J12-B | 1 | S1-2 | 4 |
| 3 | J12-C | 1 | XK1-1 | 4 |
| 4 | J12-D | 1 | TB1-1 | 4 |
| 5 | J12-E | 1 | TB1-3 | 4 |
| 6 | J12-F | 1 | TB1-5 | 4 |
| 7 | J12-G | 1 | TB1-7 | 4 |
| 8 | J12-H | 1 | TB1-9 | 4 |
| 9 | J12-I | 1 | TB1-10 | 4 |
| 10 | J12-K | 1 | TB1-2 | 4 |
| 11 | J12-L | 1 | TB1-4 | 4 |
| 12 | J12-M | 1 | TB1-6 | 4 |
| 13 | J12-N | 1 | TB1-8 | 4 |
| 14 | XDS1 | - | TB1-21 | 4 |
| 15 | XDS2 | - | TB1-25 | 4 |
| 16 | XDS3 | - | TB1-29 | 4 |
| 17 | XDS4 | - | TB1-33 | 4 |
| 18 | XDS5 | - | TB1-37 | 4 |
| 19 | XDS6 | - | TB1-39 | 4 |
| 20 | XDS7 | - | TB1-23 | 4 |
| 21 | XDS8 | - | TB1-27 | 4 |
| 22 | XDS9 | - | TB1-31 | 4 |
| 23 | XDS10 | - | TB1-35 | 4 |
| 24 | S1-6 | - | XK1-3 | 4 |
| 25 | S1-3 | - | TB1-40 | 4 |
| 26 | S1-4 | - | TB1-50 | 4 |

NOTES:

1. AFTER SOLDERING, INSTALL INSULATION. FIND NO. 2, .62 LONG, OVER EACH CONTACT OF CONNECTOR, FIND NO. 1.
2. EACH WIRE NOT TERMINATING AT FIND NO. 1 SHALL BE STRIPPED .25± .06 INCH AND TINNED.
3. INSTALL STRAPS, FIND NO. 3 AT APPROXIMATELY ONE INCH INTERVALS AND AT EACH WIRE BREAKOUT (25 MINIMUM).
4. OPTIONAL WIRING: ALL WIRES MAY BE WHITE INSTEAD OF COLOR CODED.
5. MARK WIRES WITH WIRE NO. 5 (SEE TABLE) AT INTERVALS OF 3 INCHES.
6. FAULT LOCATING INDICATING BOX WIRING HARNESS IS PART NO. 70-515.

| FIND NO. | PART OR IDENTIFYING NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|
| 4 | TYPE-E-22 | AR | WIRE, ELEC. INSULATED HIGH TEMP. 600 V. NO. 22 AWG SIZE (302 IN.) | MIL-W-16878 4 | SEE NOTE 3 |
| 3 | MS 17821-1-9 | AR | STRAP, CABLE, ADJUSTABLE | | |
| 2 | TYPE-F, FORM Ua, GRADE-a, CLASS I CATEGORY 1 | AR | INSULATION, ELECTRICAL | MIL-I-631 | |
| 1 | 69-502-7 | 1 | CONNECTOR, RECEPTACLE | | |

LIST OF MATERIAL

Figure 6-12. Fault locating indicating box wiring harness (Sheet 2 of 2)

## Section IV. CONVENIENCE RECEPTACLE ASSEMBLY

### 6-57. GENERAL.

The 50/60 hertz convenience receptacle assembly (A22) contains a 125 volt, 15 ampere duplex receptacle. Each receptacle has a spring-loaded weatherproof cover. The receptacles are connected in parallel electrically, and are protected by a 15 ampere circuit breaker.

### 6-58. 50/60 HERTZ CONVENIENCE RECEPTACLE ASSEMBLY.

6-59. REMOVAL. To remove the assembly (located below the control cubicle), disconnect plug P48 from the receptacle connector J48 in the rear of the assembly, then remove the six screws and lockwashers securing the assembly to the rear housing.

6-60. DISASSEMBLY. Refer to figure 6-13 and disassemble the 50/60 hertz convenience receptacle assembly in the order of index numbers assigned. Pay particular attention to the following:

a. Remove six screw assemblies (1) and separate the cover (9) from the housing (24).

b. Tag and disconnect wires from connector (4) circuit breaker (20) and the duplex receptacle (17).

6-61. CLEANING. Clean all components with a lint-free cloth moistened with an approved cleaning solvent and dry thoroughly.

### 6-62. INSPECTION.

a. Inspect connectors for bent, broken and missing pins. Refer to table 6-5, and check wires for continuity, shorts to case and surrounding pins.

b. Check terminal lugs and soldered connections for condition and security.

c. Check circuit breakers and receptacles for continuity.

d. Inspect sheet metal parts for dents, cracks, and distortion.

### 6-63. REPAIR.

a. Repair defective wiring in accordance with table 6-5.

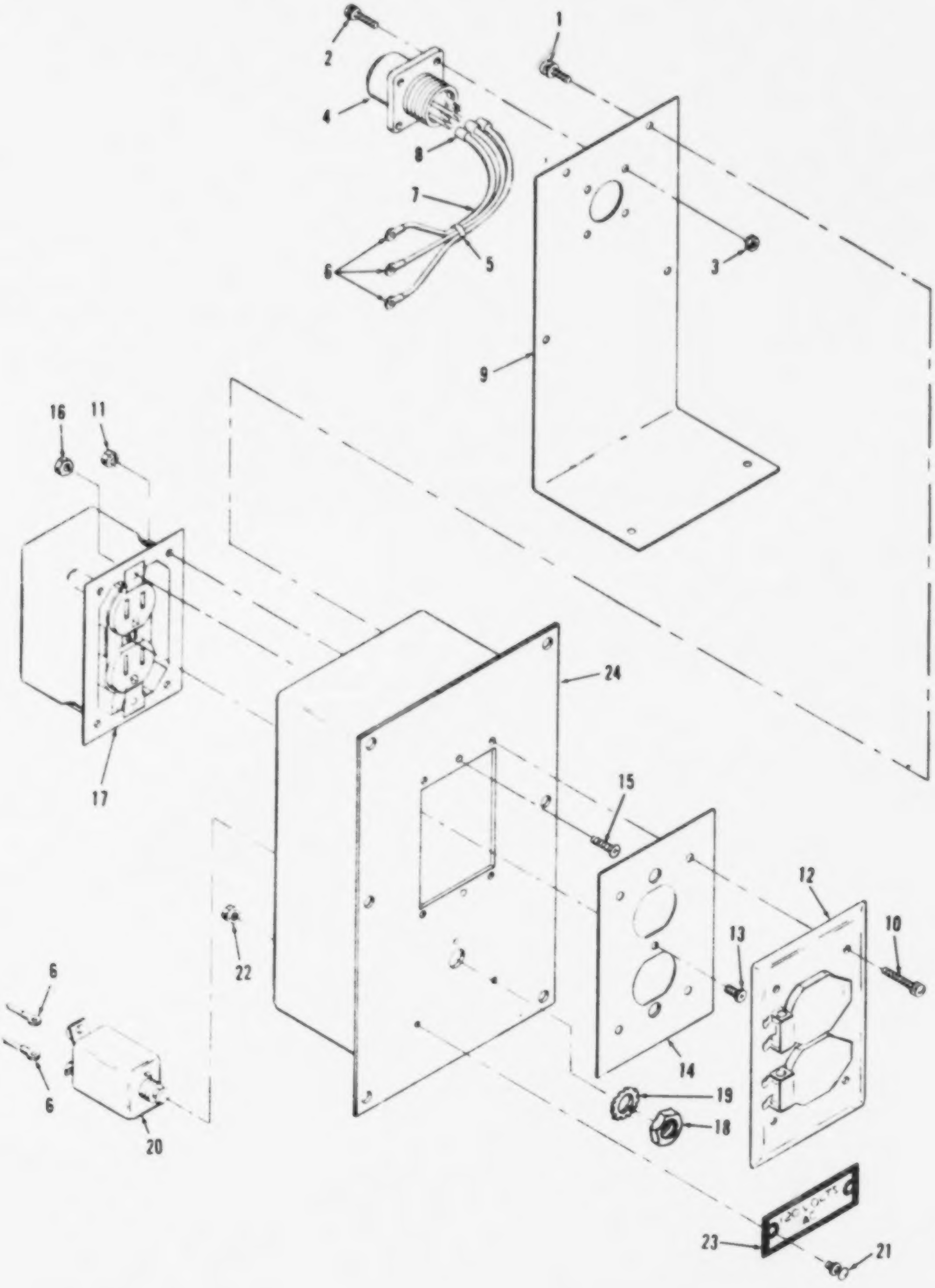
b. Straighten dented or distorted sheet metal parts using proper tools.

6-64. REASSEMBLY. Refer to figure 6-13 and reassemble 50/60 hertz convenience receptacle assembly in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Connect wires in accordance with table 6-5.

b. Install connector plug (4) with keyway up.

6-65. INSTALLATION. Install the 50/60 hertz convenience receptacle assembly in the rear housing and secure in position with six screws and lockwashers. Connect plug P48 to connector J48 in the rear of the assembly.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22
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6
120 VOLTS AC

Figure 6-13. 50/60 hertz convenience receptacle assembly, exploded view

Legend to figure 6-13:

1. Screw assembly (6)
2. Screw assembly (4)
3. Nut assembly (4)
4. Connector
5. Cable strap
6. Terminal lug
7. Wire (5)
8. Insulating tubing
9. Cover
10. Screw assembly (4)
11. Nut assembly (4)
12. Cover
13. Screw (2)
14. Gasket
15. Screw assembly (2)
16. Nut assembly (2)
17. Duplex receptacle
18. Nut
19. Lockwasher
20. Circuit breaker
21. Screw (2)
22. Nut (2)
23. Identification plate
24. Housing

Table 6-5. 50/60 Hertz Convenience Receptacle Assembly

| WIRE IDENT NO. | FROM | TERMINATION NOTE | TO | WIRE LENGTH (INCHES) | TERMINATION NOTE | COLOR IDENT |
|---|---|---|---|---|---|---|
| X9JJ12 | J48-B | 2 | CB3-1 | 7 | 3 | Black |
| X12NN12 | J48-C | 2 | J55-2 | 12 | 3 | Black |
| JUMPER NO. 1 | J55-1 | 3 | CB3-1 | 6 | 3 | None |
| G1A12 | J55-3 | 3 | GROUND LUG | 11 | 3 | Black |

NOTES

1. Marking of wire numbers shall be in accordance with Military Specification MIL-W-5088.
2. Solder, using Federal Specification QQ-S-571, Sn 60.
3. Secure ends with terminal lugs, MS25036-156.
4. Strip all wires 0.38 inch (9.652 mm).
5. Wire is M5086/2-12-9 per MIL-W-5086.
6. Use 5/8 inch (15.875 mm) long insulation tubing over each contact after soldering.
7. Insulation is TYPE F FORM Ua, GRADE A, CLASS 1, CATA-1 per MIL-I-631.
8. Cable straps MS3367-4-9 are to installed at 3 inch (76.2 mm) intervals to form harness.

## Section V. EXCITER-REGULATOR

### 6-66. GENERAL.

a. The exciter A11 (figure 1-8) and voltage regulator A10 operate as integral components of the excitation system. The excitation system energizes the main rotor field coils of the generator and regulates the magnitude of the magnetic field thus produced so as to maintain a constant voltage output from the stator of the generator under all rated load conditions.

b. The excitation system is comprised of a dynamic exciter, a static exciter assembly, a voltage regulator assembly, current transformers and a cross current compensation network to permit parallel operation of two or more generator sets.

1. The static exciter and voltage regulator are electronic assemblies packaged in a single enclosure and mounted outside the generator housing.

2. The dynamic exciter consists of a field coil stator integral with the generator housing, a set of rotor coils and solid state rectifiers mounted on the generator shaft. The static exciter energizes the field coils of the dynamic exciter. The resultant field couples with the rotor coils of the exciter. The induced currents are rectified and then fed to the coils of the generator rotor, the fields of which induce the output currents in the coils of the generator stator. Brushes or slip rings are not required. The disposition of the rotors and stators of both the dynamic exciter and the generator, including the rectifier ring, are shown in figure 7-1.

c. The exciter-regulator circuitry is illustrated in figure 1-8. The assembly operates as follows:

1. The regulated exciter field voltage at pins S-R of connector J13 is obtained by means of saturable core transformer T1. The inductance of this transformer can be varied with the control winding 5-7 so that the voltage ratio between the windings 1-2 and 3-4 may be increased or decreased in proportion to the direct current flowing in the winding 5-7. When the magnitude of the control current increases the inductance decreases and there is a lowered magnetic coupling between the windings which carry the alternating currents, hence a lowered voltage output. The reverse occurs when the control current is decreased.

2. The input at J-K of connector J13 derives from current transformers CT4, CT5, CT6, on the load lines of the generator (figure 1-3). The voltage at L-M of connector J13 is from phase C (T9 - T12 on generator). The two inputs are combined by T1 (figure 1-8) under control of winding 5-7, then rectified by bridge CR1 through CR4 and fed to the exciter field stator winding from S-R of connector J13. In the event of a short circuit, the voltage at L-M can drop to zero but there is a high voltage at J-K from the current transformers so that the exciter provides sufficient field for the generator output to actuate the protective devices to shut down the set.

3. The voltage at L-M of connector J1 is compared to the reference voltage at Q1 (located in voltage regulator A10) and Zener diode VR1 of the differential amplifier Q1 - Q2. Any difference or error signal at the collector of Q2 is amplified by Q5 - Q6 and Q3 - Q4 and then fed to the control

winding 5-7 of the control transformer T1 which increases or decreases the exciter field coil current to reduce the error signal to zero thereby maintaining the output of the generator set within the range as preset by R33. The networks R31-C1 and R32-C3 are utilized for phase shift compensation. If hunting is present, adjustment of R32 will provide the proper amount of feedback to eliminate the hunting. Adjustment of R31 will smooth and improve the transient response.

4. The voltage at pins A-B of connector J9 is derived from phase C (T9 - T12 on generator) through the operators voltage adjust rheostat and from the cross current compensation network (figure 1-3) when two or more generator sets are connected in parallel. This voltage is stepped down in transformer T5, rectified by bridge CR12 - 15, filtered by R16, R22, C2, C5 and fed to the reference side of the differential amplifier Q1-Q2.

5. The generator output voltage is determined by the level of the reference voltage and is controlled by the setting of R33 which adjusts the range voltage and operators rheostat (R2, figure 1-3) which sets the actual output. During parallel operation, the reference voltage is dependent on the cross current compensation network. For example, if one generator draws more current, the network will increase the magnitude of the reference voltage causing the voltage regulator to sense more voltage and thereby causing a decrease in current to the exciter field stator winding. This provided parallel operation with droop.

6. Power for the transistor amplifiers and the control winding (5-7 of T1) current is obtained from pins L-M of connector J13 thru stepdown transformer T4 and bridge rectifier CR8 through CR11. Diode CR17 and resistor R21 provide positive feedback to the amplifiers to enhance the gain.

7. When the start switch of the generator set is actuated, 24 volts D.C. is applied to the exciter field stator windings at pins S-R of connector J13 thru the limiting resistor R17A, R17B and isolation diode CR16 from input pins C-D of connector J11 (field flashing). The purpose is to quickly build up the magnetic field in the main rotor windings to produce an immediate output from the generator. The flashing voltage is then automatically removed.

## 6-67. TEST AND REMOVAL.

a. Symptom and Isolation of Malfunction. A malfunction of the voltage regulator section (A10) is usually indicated by a high generator output voltage with no control. A malfunction of the exciter section (A11) is usually indicated by no generator output or by low output voltage when the load is applied. To isolate the malfunction, proceed as follows:

WARNING

Exercise extreme care not to touch electrical connections when working on the exciter-regulator assembly with the generator set operating.

NOTE

Remove cover from exciter regulator to gain access to test points, see figure 6-14.

1. With the generator set operating at rated speed, measure the voltage across (A10)TB1-7 and (A10)TB1-8 (nominal voltage is 105 VAC). Refer to figure 1-8. If sensing voltage at TB1-7 and TB1-8 is normal, measure voltage across (A10)TB2-6

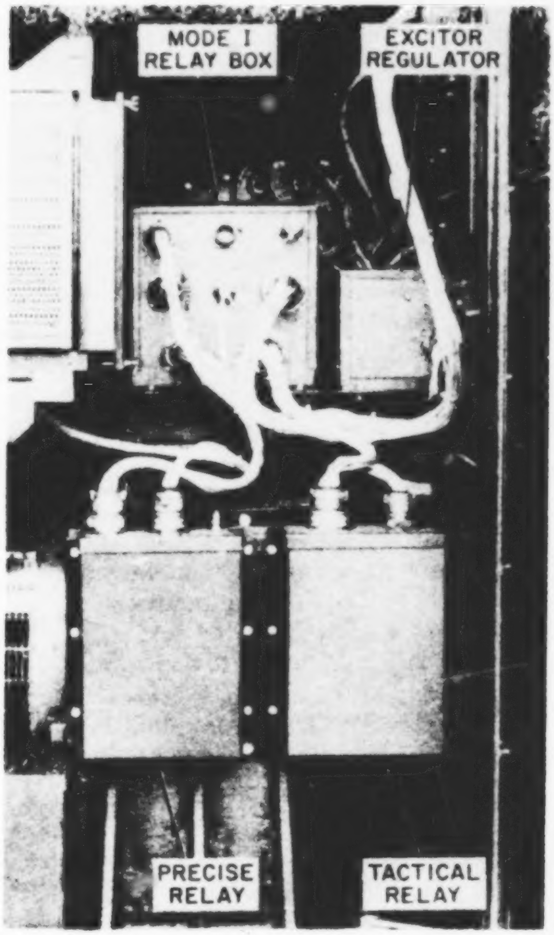

Figure 6-14. Location of exciter regulator and mode I precise and tactical relay assemblies

and (A10)TB2-7, minimum voltage should be 50 VAC.

(a) If there is no voltage at TB2-6 and TB2-7, measure voltage across (A11)TB2-2 and (A11)TB2-3 which is the generator coil voltage (T9-T12). Shut down generator set if voltages are normal.

(b) Measure for continuity from plug P11 pin H to plug P11 pin G, the reading should be 21 ohms. Pins G and H of J11 should read 13 ohms, observe polarity.

(c) If circuit is open, replace exciter (A11). If all readings are normal, replace regulator (A10).

2. To check exciter regulator performance when there is no generator output voltage, connect a dc voltmeter (0-50 volt scale) across resistor (A11)R17 and observe for field flashing voltage when generator set is started.

(a) If flashing voltage is observed, connect an ac voltmeter (0-150 volt scale) across choke (A11)L1 and observe for ac voltage when the field is flashed.

(b) If voltage is observed across choke but the generator output voltage does not build up, shut down generator set and check for shorted diode CR1, CR2, CR3, or CR4. If diodes are shorted, replace the exciter.

(c) If diodes check out, disconnect wires U135C16 and U134C16 from (A11)TB1-2 and TB1-3, connect wires together.

(d) Start generator set; if voltage builds up, check for short circuit in booster transformers CT4, CT5, or CT6, refer to figure 1-3. Check transformer wiring.

(e) If voltage doesn't build up, transformer (A11)T1 is defective.

3. To inspect for the cause of low output voltage when the generator set is under load, shut down generator set and check for an open diode (A11)CR1, CR2, CR3, or CR4. If defective, replace the exciter assembly.

(a) If diodes are not defective, connect ac ammeter (0-25 amp scale) in series with wire from TB1-6 and TB1-6 terminal and measure current from the booster transformers CT4, CT5 or CT6.

(b) With the generator set under full rated load, the reading should be 14 ± 2 amps. A low reading indicates an open current transformer (CT4, CT5, or CT6).

(c) If voltage reading is normal, connect a dc ammeter (0-25 amp) in series with the exciter field and a dc voltmeter (0-30 volt scale) across (A11)TB1-5(+) and (A11)TB1-6.

(d) Start the generator set and measure exciter field voltage and current under full rated load. The reading should be 10 ± 2 volts dc at 6 to 8 amps.

(e) If readings are low, replace exciter-regulator. If readings are normal or high, test generator diodes for an open condition.

b. Removal. Disconnect plug P13 and P9 from the exciter regulator, then remove the four screws and nuts securing the assembly in position. See figure 6-14.

## 6-68. TEST.

a. Connect the exciter-regulator to test equipment as illustrated in figure 6-15 and perform test specified in procedural analysis table 6-6.

NOTE

Figure 1-8 is the exciter-regulator schematic. Refer to this schematic when checking individual components for their required values or operating characteristics.

b. Remove test equipment.

## 6-69. DISASSEMBLY.

Refer to figure 6-16 and disassemble the exciter regulator in the order of index numbers assigned. Pay particular attention to the following:

NOTE

The exciter-regulator assembly should be tested prior to disassembly as specified in paragraph 6-68. Disassemble the exciter-regulator assembly to the extent necessary to accomplish repair.

a. Remove cover (3, figure 6-16) by removing eight screw assemblies (2).

b. Tag and disconnect wires of wiring harness (21) from components. Note polarity and location of components when tagging.

c. Exercise care not to apply excessive heat when unsoldering components.

d. Refer to figure 6-17 and disassemble the voltage regulator assembly (4, figure 6-16) to the extent necessary to accomplish repair.

e. Refer to figure 6-18 and disassemble the voltage regulator sub-assembly (3, figure 6-17) to the extent necessary to accomplish repair.

## 6-70. CLEANING.

Clean all components with a clean lint-free cloth moistened with an approved cleaning solvent and dry thoroughly.

## 6-71. INSPECTION.

a. Harness

1. Inspect harness wiring for proper continuity and defective insulation.

Table 6-6. Exciter-Regulator (A10-A11) Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECKOUT PROCEDURE |
|---|---|---|---|---|
| 1. | Connect the static exciter-regulator to the test equipment depicted in figure 6-15 and open all switches. | (make certain that regulator board is properly connected to static exciter). | (Refer to Schematic Diagram Figure 1-8). | |
| 2. | Energize the 24 VDC power source. Close switch S2. | Ammeter A2 should indicate approximately 2 amperes. | Defective component in field flashing circuit. | Check resistors R17A, R17B, diode CR16, bridge CR1-4 and continuity of T1 winding 3-4. |
| 3. | Open switch S2. Energize 60 HZ power source, close switch S1 and adjust so V1 reads 120 volts. Adjust R1 so that A3 reads 0. | A2 should read 4.8 amperes. | Open reactor L1. Defective transformer T1. Shorted diode in bridge CR1-4. Shorted capacitor C1. See step 9. | Make continuity check of L1 and T1. Check all diodes in CR1-4. Check C1. Replace where necessary. See step 9. |
| 4. | Readjust R1 so that A3 reads 1.9 amperes. | A2 should read approximately .45 amperes. | Shorted CR-7. Defective bridge CR1-4, L1, T1, shorted C3. See step 10. | See step 10. Check CR-7, CR1-4, L1, T1, C3. Replace where necessary. |

Table 6-6. Exciter-Regulator (A10-A11) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 5. | Readjust R1 so that A3 reads zero then put switch S3 in position 1. | A2 should increase over reading in step 3 to 9.9 amperes. | Leads to J and K on connector J13 reversed. | Recheck step 3. |
| 6. | Set switch S3 in position 2. | A2 should decrease from step 5. | Recheck step 5. | |
| 7. | Set switch S3 in "OFF" position and set R1 to zero ohms. Adjust voltage at V1 until A3 begins to increase from 0. | The increase at A3 should occur when V1 equals 104 VAC.<br>NOTE<br>Above indication is obtained by going through the 104 volt level from a lower voltage. | Range pot R33 improperly adjusted. | Reset pot R33 so that A3 begins increase at 104 VAC. |
| 8. | Refer to schematic diagram figure 1-8. With power input at 120 VAC, adjust R1 so that A3 reads 0. | | | |

Table 6-6. Exciter-Regulator (A10-A11) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 9. | Measure voltage between the following points in schematic Figure 1-8. | | | |
| | a. AA to CC | a. 11 volts. | a. Defective T5, CR12-15, R16, R1, R2, C2 and C5. | a. Check T5 for shorted or open windings, check diodes in bridge. Check for open resistors or shorted capacitors. |
| | b. AA to DD | b. 50 volts. | b. Defective T4, CR8-11. | b. Check diodes in bridge. Check T4 windings for opens or shorts. |
| | c. AA to FF | c. 0 volts | c. Defective Q1-Q2, R3, R4, R5, R6, R7, R8, C4, VR1. | c. Check and replace Q2, C4. Check resistor for proper value and opens. |
| | d. AA to EE<br>See NOTE 2 | d. 8.2 volts | d. Defective Q5 or Q6. Incorrect value R8, R9, R18, R19, R20. | d. Check and replace transistors where necessary. Check resistor values. |
| | e. AA to GG | e. 50 volts | e. Defective Q3, Q4, R9 or CR17. | e. Check and replace transistors where necessary. Check resistor and diode. |

Table 6-6. Exciter-Regulator (A10-A11) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 9. | Measure voltage between the following points in schematic Figure 1-8. (cont) | | | |
| | f. HH to BB | f. 5 volts. | f. Defective VR1. | f. Check and replace if necessary. |
| 10. | Readjust R1 so that A3 reads 2.4 amperes maximum and measure the voltage between the same points as follows: | (Check for shorted CR7 if A3 will not read 2.4 amperes). | | |
| | a. AA to CC | a. 13 volts. | a. See 9a. | a. See 9a. |
| | b. AA to DD | b. 50 volts. | b. See 9a. | b. See 9b. |
| | c. AA to FF | c. 2.6 volts. | c. Shorted C4. See 9c | c. Check and replace C4. See 9c. |
| | d. AA to EE See Note 2. | d. 2 volts. | d. Shorted or open CR17. See 9d. | d. Check and replace CR17 See 9d. |
| | e. AA to GG | e. 1 volt. | e. See 9e. | e. See 9e. |

Table 6-6. Exciter-Regulator (A10-A11) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 10. | Readjust R1 so that A3 reads 2.4 amperes maximum and measure the voltage between the same points as follows: (continued) | (Check for shorted CR7 if A3 will not read 2.4 amperes). (continued) | | |
| | f. HH to BB | f. 5 volts. | f. See 9f. | f. See 9f. |

NOTES:

1. All voltages in steps above are ± 20%.
2. To reach test point EE, remove screws holding printed circuit board and test from below board.
3. If regulation is unsatisfactory after check-out, recheck CR17 for open or short and R21 for correct value.
4. If stability is unsatisfactory, check R14, R31, R32 for correct values and C1, C3 for opens or shorts.
5. Prior to starting test, set variable resistors R31, R32, and R33 on voltage regulator to mid-points. During step 9 it may be necessary to readjust R33 so test conditions can be met. If readjustment is required, repeat steps 5 through 8, record results, reverify step 9, then continue test. Leave R33 at position at which step 9 conditions are met.

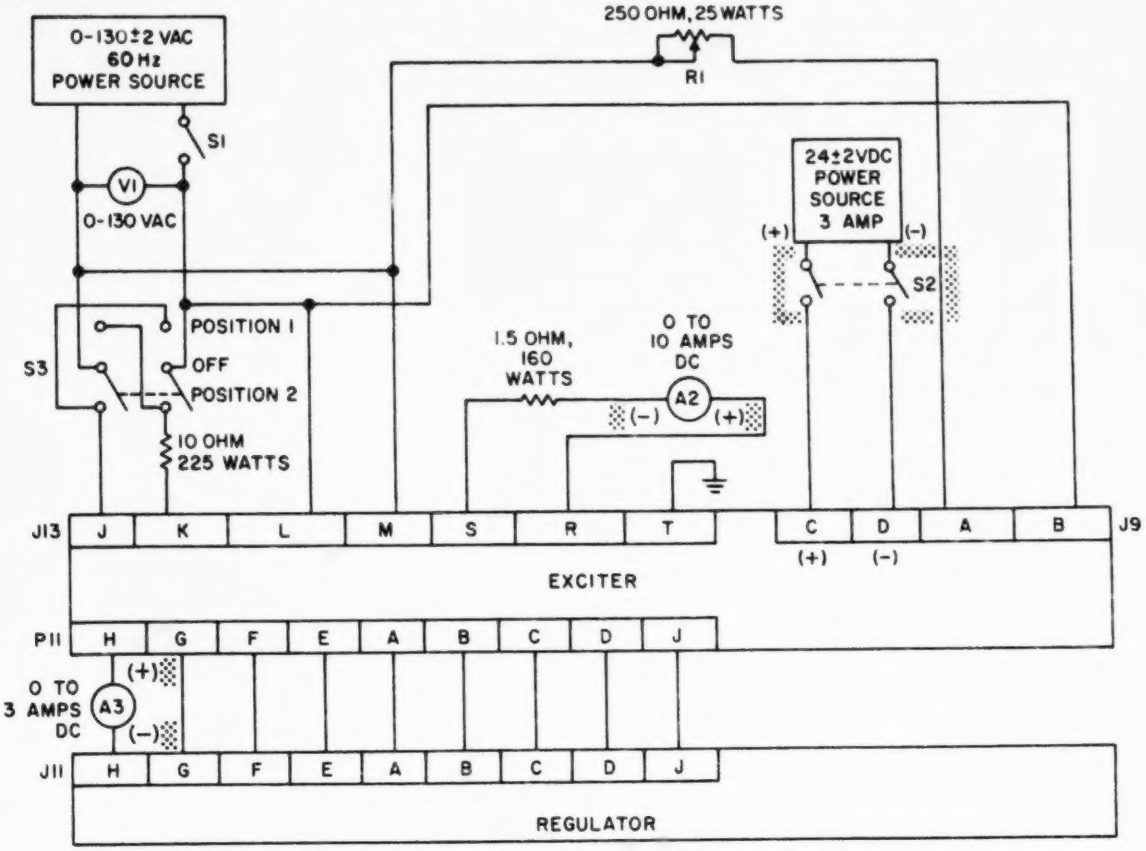
0-130±2 VAC
60 Hz
POWER SOURCE
S1
V1
0-130 VAC
250 OHM, 25 WATTS
R1
24±2VDC
POWER
SOURCE
3 AMP
(+)
(-)
S2
S3
POSITION 1
OFF
POSITION 2
10 OHM
225 WATTS
1.5 OHM,
160
WATTS
0 TO
10 AMPS
DC
A2
(-)
(+)
J13
J
K
L
M
S
R
T
C
D
A
B
J9
(+)
(-)
EXCITER
P11
H
G
F
E
A
B
C
D
J
0 TO
3 AMPS
DC
A3
(+)
(-)
J11
H
G
F
E
A
B
C
D
J
REGULATOR

Figure 6-15. Exciter regulator (A10, A11) test setup

2. Inspect harness connector for damaged, threads; bent, loose or missing pins and for shorts.

b. Electrical Components.

1. Check electrical components for opens, shorts, continuity, and proper values.

2. Check diodes for forward and reverse values. Measured from anode (+) to cathode (-) value should be low. Reverse leads, value should be infinity.

c. Printed Circuit Board.

1. Inspect printed circuit boards (component side) for damage, burns, discolored areas and signs of overheating.

2. Inspect components for security.

3. Inspect circuits of printed circuit boards for breaks and damage.

d. Inspect terminal boards for cracked insulation, stripped threads and missing jumper strips.

e. Inspect wiring harnesses for evidence of insulation breakdown and security of connections, refer to figure 6-19, and figure 6-20.

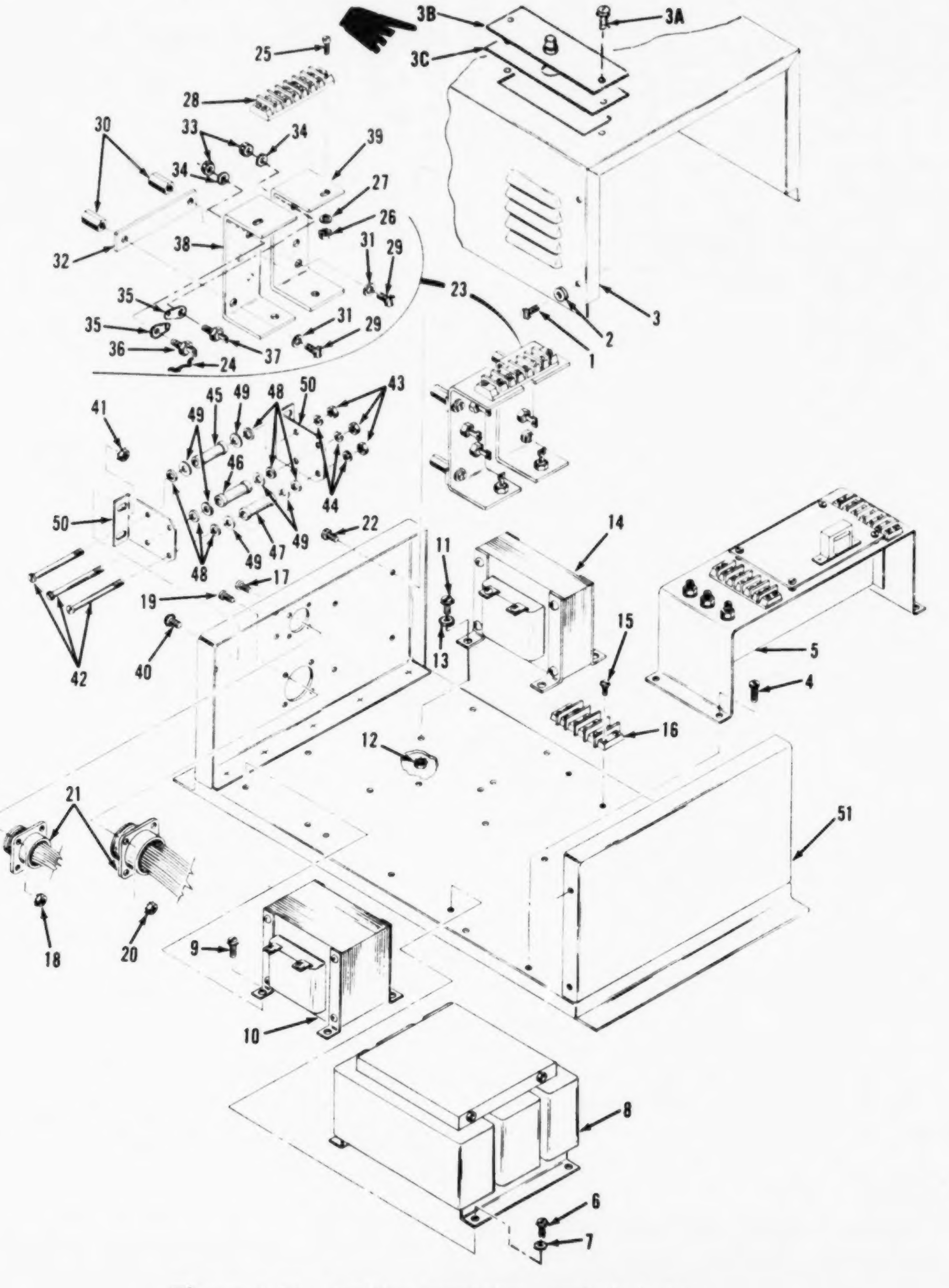
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Figure 6-16. Exciter regulator, exploded view

Legend to figure 6-16:

1. Screw and washer assembly (8)
2. Washer (8)
3. Cover assembly
3A. Screw (2)
3B. Plate
3C. Gasket
4. Screw and washer assembly (4)
5. Voltage regulator assembly
6. Screw and washer assembly (4)
7. Washer (4)
8. Transformer
9. Screw and washer assembly (4)
10. Control transformer
11. Screw and washer assembly (4)
12. Nut and washer assembly (4)
13. Washer (4)
14. Reactor
15. Screw and washer assembly (2)
16. Terminal board
17. Screw and washer assembly (4)
18. Nut and washer assembly (4)
19. Screw and washer assembly (4)
20. Nut and washer assembly (4)
21. Wiring harness
22. Screw and washer assembly (4)
23. Bridge rectifier and field
24. Electrical wire
25. Screw and washer assembly (2)
26. Nut and washer assembly (2)
27. Washer (2)
28. Terminal board
29. Screw (4)
30. Spacer (4)
31. Washer (4)
32. Insulated plate (2)
33. Nut (5)
34. Washer (5)
35. Terminal lug (2)
36. Diode (2)
37. Diode (3)
38. Diode heatshield
39. Diode heatshield
40. Screw and washer assembly (4)
41. Nut and washer assembly (4)
42. Screw (4)
43. Nut (4)
44. Lockwasher (4)
45. Resistor (2)
46. Resistor
47. Resistor
48. Washer (8)
49. Washer (8)
50. Bracket (2)
51. Chassis

## 6-72. REPAIR.

a. Repair voltage regulator sub-assembly wiring in accordance with table 6-7.

b. Repair printed circuit board as follows:

1. Restencil all illegible reference designations.

CAUTION

Prolonged use of soldering equipment could cause damage to components due to excessive heat.

2. Repair printed circuits by soldering a jumper wire across defective area.

3. Replace all defective components.

4. Solder replacement components on the printed circuit boards using solder conforming to Federal Specification QQ-S-571 Sn 60.

5. Solder joints and/or component leads must not project more than 0.094 inch (2.387 mm) beyond surface of board.

6. After replacement of components on the printed circuit boards, coat the boards with protective coating, conforming to Military Specification MIL-I-46058, grade S, type PUR, 0.005 inch (0.127 mm) minimum thickness. Air bubbles should be prevented during coating so that legibility of identification or information markings are not impaired. The coating shall be applied so that it anchors the components to the board. Terminals utilized for connection to external circuits shall not be coated.

Legend to figure 6-16:

1. Screw and washer assembly
2. Washer (8)
3. Cover assembly
4. Screw and washer assembly (4)
5. Voltage regulator assembly
6. Screw and washer assembly (4)
7. Washer (4)
8. Transformer
9. Screw and washer assembly (4)
10. Control transformer
11. Screw and washer assembly (4)
12. Nut and washer assembly (4)
13. Washer (4)
14. Reactor
15. Screw and washer assembly (2)
16. Terminal board
17. Screw and washer assembly (4)
18. Nut and washer assembly (4)
19. Screw and washer assembly (4)
20. Nut and washer assembly (4)
21. Wiring harness
22. Screw and washer assembly (4)
23. Bridge rectifier and field
24. Electrical wire
25. Screw and washer assembly (2)
26. Nut and washer assembly (2)
27. Washer (2)
28. Terminal board
29. Screw (4)
30. Spacer (4)
31. Washer (4)
32. Insulated plate (2)
33. Nut (5)
34. Washer (5)
35. Terminal lug (2)
36. Diode (2)
37. Diode (3)
38. Diode heatshield
39. Diode heatshield
40. Screw and washer assembly (4)
41. Nut and washer assembly (4)
42. Screw (4)
43. Nut (4)
44. Lockwasher (4)
45. Resistor (2)
46. Resistor
47. Resistor
48. Washer (8)
49. Washer (8)
50. Bracket (2)
51. Chassis

## 6-74. REASSEMBLY.

Refer to figure 6-16 and reassemble the exciter-regulator in the reverse order of index numbers assigned. Pay particular attention to the following:

NOTE

Mount connectors with keyway in top position.

a. Refer to figure 6-18 and reassemble the voltage regulator sub-assembly.

b. Refer to figure 6-17 and reassemble the voltage regulator assembly.

c. Secure components mechanically prior to wiring.

d. Connect wires on voltage regulator sub-assembly to components according to table 6-7.

e. Connect wiring harnesses in accordance with figures 6-19 and 6-20.

f. Exercise care not to apply excessive heat when soldering components.

g. Check wiring to components. Refer to figure 1-9.

h. Test exciter-regulator as specified in paragraph 6-68.

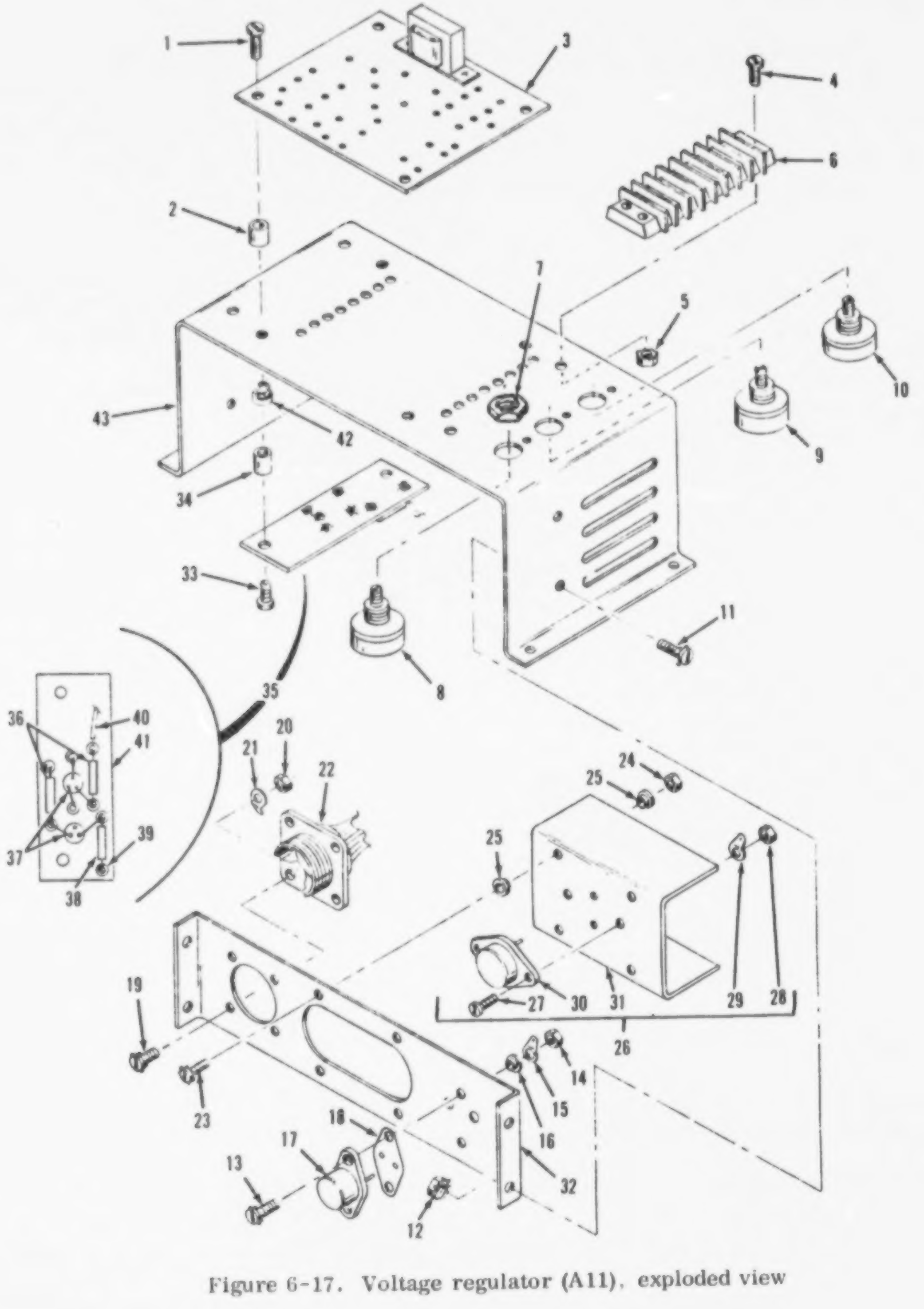
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Figure 6-17. Voltage regulator (A11), exploded view

Legend to figure 6-17:

1. Screw assembly (4)
2. Standoff (4)
3. Voltage regulator
4. Screw assembly (4)
5. Nut assembly (4)
6. Terminal board (2)
7. Nut
8. Variable resistor
9. Variable resistor
10. Variable resistor
11. Screw assembly (4)
12. Nut assembly (4)
13. Screw assembly (2)
14. Self locking nut (2)
15. Terminal lug
16. Shoulder washer (2)
17. Transistor
18. Mica washer
19. Screw assembly (4)
20. Nut assembly (4)
21. Terminal lug
22. Wiring harness
23. Screw assembly (4)
24. Self locking nut (4)
25. Shoulder washer (8)
26. Heatsink assembly
27. Screw assembly (2)
28. Self locking nut (2)
29. Terminal lug
30. Transistor
31. Heatsink
32. Bracket
33. Screw assembly (2)
34. Standoff (2)
35. Component board assembly
36. Resistor (2)
37. Transistor (2)
38. Resistor
39. Eyelet (8)
40. Wire
41. Component board
42. Clinch nut (4)
43. Chassis assembly

i. Install the exciter after adjustments.

### 6-75. INSTALLATION.

Refer to figure 6-14 and install the exciter regulator. Secure the assembly in position with four screws and nuts, then connect plugs P9 and P13.

### 6-76. ADJUSTMENT.

a. Set voltage range resistor R33 in a position so that generator output voltage can be adjusted at any loads between no load and rated load. Adjust VOLTAGE ADJUSTMENT resistor R2 (on control cubicle to meet the following requirements.)

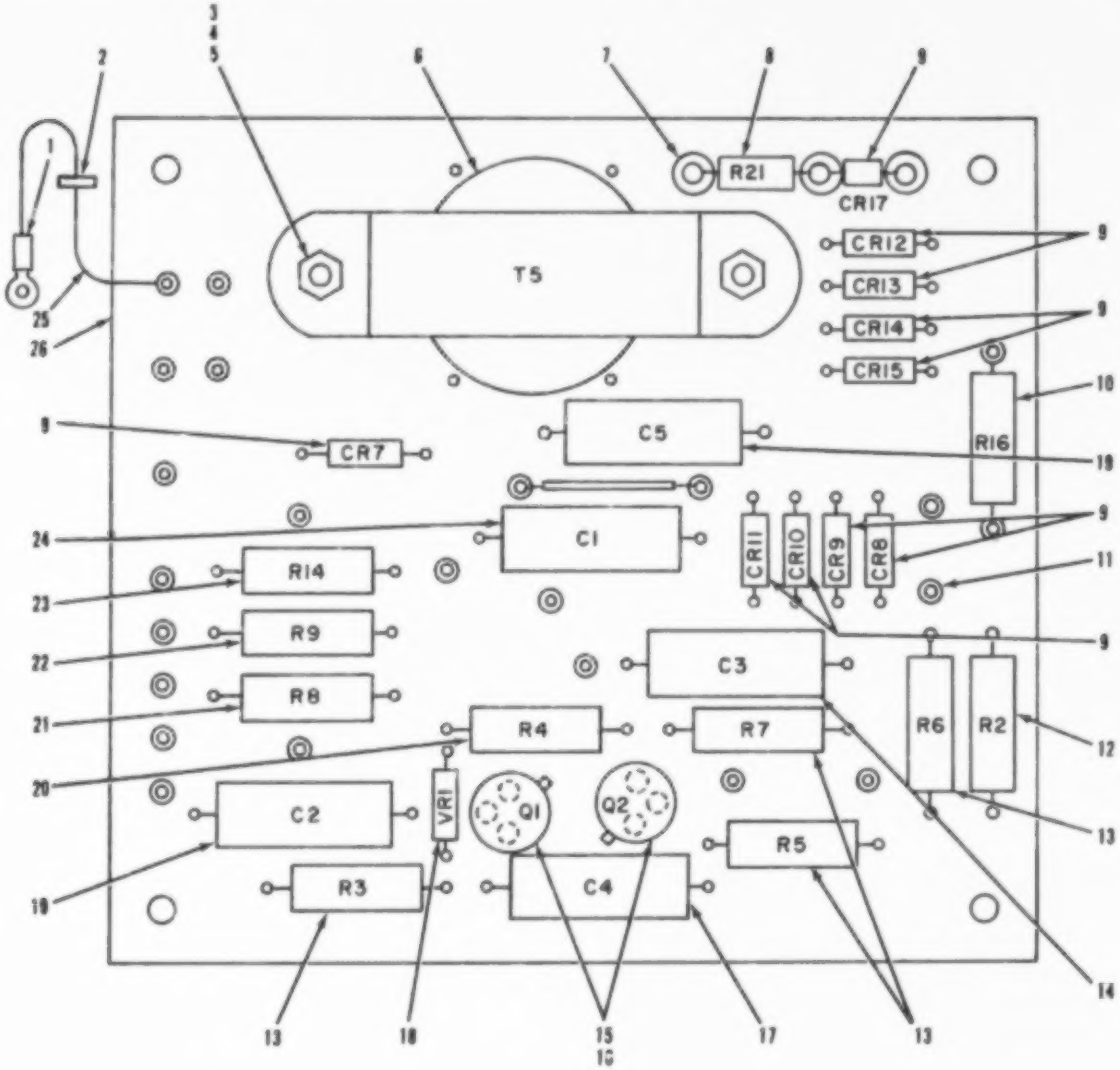
1. Between 395 and 480 volts for the 240/416 volt connection and between 197 and 240 volts for the 120/208 volt connection; (60 Hz set).

2. Between 380 and 426 volts for the 240/416 volt connection and between 190 and 213 volts for the 120/208 volt connection; (50 Hz set).

b. Set feedback resistor R32 and rate resistor R31 to mid-point, and start generator set. If voltage is stable turn feedback resistor R32 counterclockwise until voltage becomes unstable, then turn clockwise until voltage is stable

1. If voltage is still unstable, turn feedback resistor R32 slowly counterclockwise until voltage is stable.

2. If voltage stability is still not achieved, adjust rate resistor R31 slightly counterclockwise from mid-point and readjust with feedback resistor R32.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6
7
8
9
R21
CR17
T5
CR12
CR13
9
CR14
CR15
9
25
26
10
R16
9
CR7
C5
19
C1
24
CR11
CR10
CR9
CR8
9
11
R14
23
R9
22
9
C3
R8
21
R4
R7
R6
R2
12
20
VR1
Q1
Q2
C2
R5
13
19
R3
C4
14
13
18
15
16
17
13

Figure 6-18. Voltage regulator subassembly (A11)

Legend to figure 6-18:

1. Terminal lug (17)
2. Cable strap (16)
3. Screw assembly (2)
4. Nut assembly (2)
5. Washer (2)
6. Transformer
7. Eyelet (3)
8. Resistor
9. Diode
10. Resistor
11. Eyelet (24)
12. Resistor
13. Resistor (4)
14. Capacitor (14)
15. Transistor (2)
16. Transistor pad (2)
17. Capacitor
18. Diode
19. Capacitor (2)
20. Resistor
21. Resistor
22. Resistor
23. Resistor
24. Capacitor
25. Lead
26. Printed circuit board

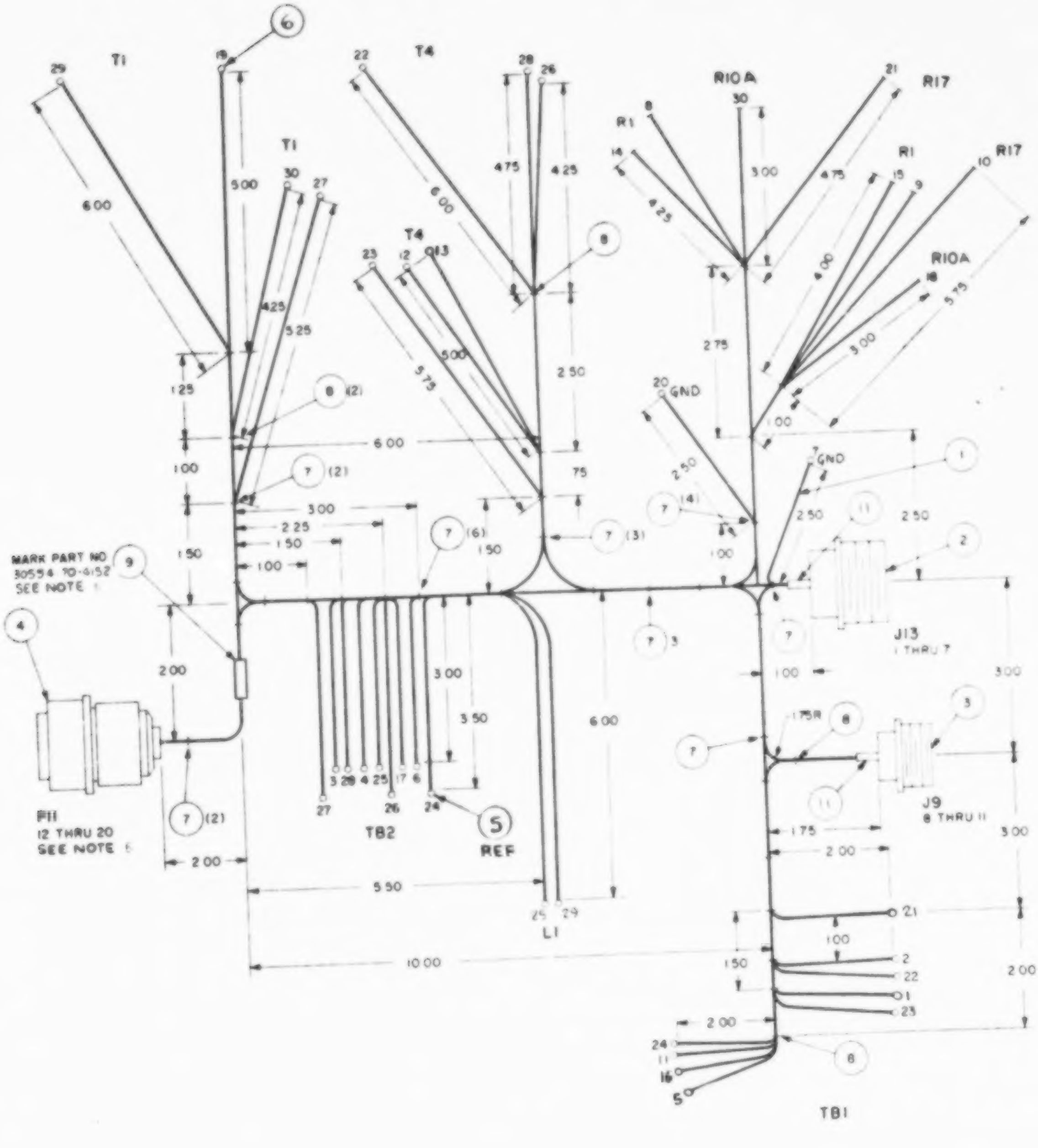

29
T1
19
6
22
T4
28
26
R10A
30
21
R17
R1
8
14
600
500
T1
30
27
475
425
300
475
R1
15
9
10
R17
425
600
425
525
8
T4
23
12
Q13
400
R10A
18
575
575
500
275
300
125
250
20
GND
8
(2)
100
600
100
7
(2)
75
250
GND
1
300
7
(4)
11
225
7
(6)
7
(3)
250
250
2
150
150
150
100
MARK PART NO
30554 70-4152
SEE NOTE 1
9
100
100
4
7
3
7
J13
1 THRU 7
200
300
300
350
600
175R
8
3
7
11
J9
8 THRU 11
3
28
4
25
17
6
27
26
24
5
REF
TB2
F11
12 THRU 20
SEE NOTE 1
7
(2)
200
175
200
300
550
25
29
L1
21
100
1000
150
2
22
200
1
23
200
24
11
16
5
8
TB1

Figure 6-19. Exciter regulator wiring harness (Sheet 1 of 2)

| WIRE NO. | WIRE MARKING IDENTIFICATION |  | FROM | TERMN FIND NO | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
|  | COLOR | NUMBER |  |  |  |  |  |
| 1 | BLACK | U134C16 | J13-J | — | TB1-3 | 5 | 10.50 |
| 2 | BLACK | U135C16 | J13-K | — | TB1-2 | 5 | 10.50 |
| 3 | BLACK | X9EE16 | J13-L | — | TB2-3 | 5 | 13.50 |
| 4 | BLACK | X12TT16 | J13-M | — | TB2-2 | 5 | 13.00 |
| 5 | RED | P73B16 | J13-R | — | TB1-5 | 5 | 11.00 |
| 6 | RED | P67D16 | J13-S | — | TB2-1 | 5 | 12.00 |
| 7 | RED | P55AK16 | J13-T | — | GND | 6 | 4.00 |
| 8 | BLACK | X91E16 | J9-A | — | R1-1 | - | 14.50 |
| 9 | BLACK | X197H16 | J9-B | — | R1-2 | - | 12.50 |
| 10 | RED | P42C16 | J9-C | — | R17A-2 | - | 14.50 |
| 11 | RED | P67C16 | J9-D | — | TB1-6 | 5 | 9.00 |
| 12 | BLACK | X146A16 | P11-A | — | T4-3 | 6 | 18.25 |
| 13 | BLACK | X147A16 | P11-B | — | T4-4 | 6 | 18.25 |
| 14 | BLACK | X91H16 | P11-C | — | R1-1 | - | 24.00 |
| 15 | BLACK | X197J16 | P11-D | — | R1-2 | - | 22.00 |

| WIRE NO. | WIRE MARKING IDENTIFICATION |  | FROM | TERMN FIND NO | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
|  | COLOR | NUMBER |  |  |  |  |  |
| 16 | RED | P73E16 | P11-E | — | TB1-5 | 5 | 24.00 |
| 17 | RED | P67H16 | P11-F | — | TB2-1 | 5 | 10.25 |
| 18 | BLACK | V159A16 | P11-G | — | R10A-2 | - | 22.00 |
| 19 | BLACK | V160A16 | P11-H | — | T1-5 | 6 | 13.75 |
| 20 | RED | P55AJ16 | P11-J | — | GND | 6 | 18.50 |
| 21 | RED | P72A16 | TB1-1 | 5 | R17A-1 | - | 16.25 |
| 22 | BLACK | U135D16 | TB1-2 | 5 | T1-3 | 6 | 24.75 |
| 23 | BLACK | U134D16 | TB1-3 | 5 | T1-4 | 6 | 20.00 |
| 24 | RED | P67J16 | TB1-6 | 5 | TB2-1 | 5 | 20.50 |
| 25 | BLACK | X12UU16 | TB2-2 | 5 | L1-2 | 6 | 12.75 |
| 26 | BLACK | X12WW16 | TB2-2 | 5 | T4-1 | 6 | 18.00 |
| 27 | BLACK | X9FF16 | TB2-3 | 5 | T1-2 | 6 | 11.25 |
| 28 | BLACK | X9GG16 | TB2-3 | 5 | T4-2 | 6 | 17.00 |
| 29 | BLACK | X154A16 | L1-1 | 6 | T1-1 | 6 | 21.75 |
| 30 | BLACK | X153A16 | T1-7 | 6 | R10A-1 | - | 26.00 |

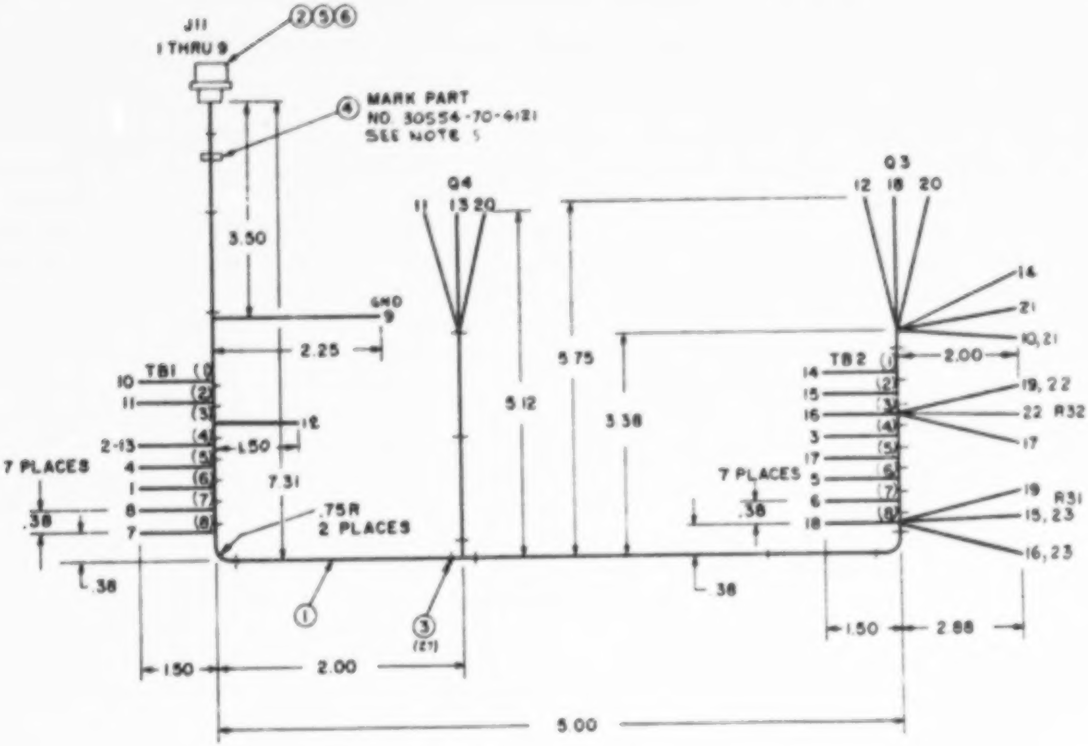
|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| 11 |  |  | TYPE F, FORM UA GRADE A, CL I CATEGORY 1 | 11 | TUBING INSULATION .106 ID X .020 WALL X .62 LG | MIL-I-631 |  |
| 10 |  |  | SN60WRAP2 | AR | SOLDER LEAD-TIN ALLOY ROSIN CORE | QQ-S-571 | NOTE 2 |
| 9 |  |  | MS39020-2 | 1 | BAND, MARKER |  | AL ALY |
| 8 |  |  | MS3367-4-9 | 5 | STRAP, TIEDOWN |  | NYLON |
| 7 |  |  | MS3367-1-9 | 28 | STRAP, TIEDOWN |  | NYLON |
| 6 |  |  | MS25036-108 | 14 | TERMINAL, LUG, CRIMP STYLE |  |  |
| 5 |  |  | MS25036-106 | 18 | TERMINAL, LUG, CRIMP STYLE |  |  |
| 4 |  |  | MS3106R18-1P | 1 | CONNECTOR, PLUG |  |  |
| 3 |  |  | MS3102R14S-6P | 1 | CONNECTOR, RECEPTACLE |  |  |
| 2 |  |  | MS3102R22-14P | 1 | CONNECTOR, RECEPTACLE |  |  |
| 1 |  |  | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 |  |
| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |

| WIRE LENGTH TOLERANCES |  |  |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE FIND NO [illegible] AND [illegible] SOLDER
3. CABLE STRAPS, FIND NO'S 7 AND 8, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088. EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. A. TRUNK BENDS TO BE 1.00 RADIUS EXCEPT WHERE OTHERWISE SPECIFIED.
   B. BREAKOUTS TO BE .50 RADIUS.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 6-19. Exciter regulator wiring harness (Sheet 2 of 2)


J11
1 THRU 9
②⑤⑥
④
MARK PART
NO 30554-70-4121
SEE NOTE 5
3.50
GND
9
2.25
TB1
10
11
12
2-13
4
1
8
7
1.50
7 PLACES
.38
7.31
.75R
2 PLACES
.38
①
③
(27)
150
2.00
Q4
11
13 20
5.12
5.75
3.38
Q3
12 18 20
14
21
10, 21
TB2
2.00
14
15
16
3
17
5
6
18
19, 22
22 R32
17
19 R31
15, 23
16, 23
7 PLACES
.38
.38
1.50
2.88
5.00

NOTES

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 5.
3. CABLE STRAPS, FIND NO. 3, SHALL BE SPACED AT APPROX. 1.50 APART UNLESS OTHERWISE SPECIFIED.
4. SOLDER.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.
6. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCHES

| WIRE NO. | IDENTIFICATION | | FROM | TERMIN FIND NO. | TO | TERMIN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | RED | -0378 | J11-6 | SOLDER | TB1-6 | SOLDER | 8.00 |
| 2 | BLUE | -0381 | J11-H | SOLDER | TB1-4 | SOLDER | 7.30 |
| 3 | W/BLK | -0392 | J11-F | SOLDER | TB2-4 | SOLDER | 16.00 |
| 4 | W/RED | -0386 | J11-E | SOLDER | TB1-5 | SOLDER | 7.50 |
| 5 | GRAY | -0385 | J11-A | SOLDER | TB2-6 | SOLDER | 15.00 |
| 6 | GRAY | -0385 | J11-B | SOLDER | TB2-7 | SOLDER | 14.50 |
| 7 | W/BLUE | -0389 | J11-C | SOLDER | TB1-8 | SOLDER | 9.00 |
| 8 | W/BLUE | -0389 | J11-D | SOLDER | TB1-7 | SOLDER | 8.50 |
| 9 | BLACK | -0384 | J11-J | SOLDER | GND | SOLDER | 6.00 |
| 10 | BROWN | -0383 | TB1-1 | SOLDER | R33-1 | SOLDER | 15.00 |
| 11 | YELLOW | -0379 | TB1-2 | SOLDER | Q4-E | SOLDER | 11.50 |
| 12 | GREEN | -0380 | A2-E3 | SOLDER | Q3-B | SOLDER | 14.50 |
| 13 | BLUE | -0381 | TB1-4 | SOLDER | Q4-C | SOLDER | 11.00 |
| 14 | W/BRN | -0391 | TB2-1 | SOLDER | R33-3 | SOLDER | 4.00 |
| 15 | VIOLET | -0382 | TB2-2 | SOLDER | R31-1 | SOLDER | 7.00 |
| 16 | W/VIOL | -0390 | TB2-3 | SOLDER | R31-3 | SOLDER | 6.50 |
| 17 | W/GRN | -0388 | TB2-5 | SOLDER | R32-3 | SOLDER | 4.50 |
| 18 | BLUE | -0381 | TB2-8 | SOLDER | Q3-C | SOLDER | 7.00 |
| 19 | W/VIOL | -0390 | R31-3 | SOLDER | R32-1 | SOLDER | 7.00 |
| 20 | GREEN | -0380 | Q3-E | SOLDER | Q4-B | SOLDER | 14.00 |
| 21 | BROWN | -0383 | R33-1 | SOLDER | R33-2 | SOLDER | 3.50 |
| 22 | W/VIOL | -0390 | R32-1 | SOLDER | R32-2 | SOLDER | 3.50 |
| 23 | VIOLET | -0382 | R31-1 | SOLDER | R31-2 | SOLDER | 3.50 |

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 6 | | | Type F, Form U, Grade A, Cl 1 Category 1 | 9 | Insulation, Electrical .027 ID X .012 Wall (#22 AWG) X .375 Lg., Color - Transparent | MIL-I-631 | |
| 5 | | | SNGOWRAP-2 | AR | Solder, LEAD-TIN ALLOY ROSIN CORE | QQ-S-571 | NOTE 4 |
| 4 | | | MS39020-1 | 1 | Band, Marker | | AL ALY |
| 3 | | | MS3367-4-9 | 27 | Strap, TIE DOWN | | NYLON |
| 2 | | | MS3102R18-1S | 1 | Connector, Receptacle | | |
| 1 | | | Type-C-22 | AR | Wire, Electrical | MIL-W-16878/2 | |

Figure 6-20. Voltage regulator wiring harness

Table 6-7. Voltage Regulator Sub-Assembly Wire Data

| WIRE IDENT NO. | FROM | TERMINATION NOTE | TO | WIRE LENGTH (±0.25 inches) | TERMINATION NOTE | COLOR IDENT |
|---|---|---|---|---|---|---|
| 1 | Terminal 1 | 1 | TB1-1 | 8.0 | 3 | Brown |
| 2 | Terminal 2 | 1 | TB1-2 | 8.0 | 3 | Yellow |
| 3 | Terminal 3 | 1 | TB1-3 | 8.0 | 3 | Green |
| 4 | Terminal 4 | 1 | TB1-4 | 8.0 | 3 | Blue |
| 5 | Terminal 5 | 1 | TB1-5 | 8.0 | 3 | W/Red |
| 6 | Terminal 6 | 1 | TB1-6 | 8.0 | 3 | Red |
| 7 | Terminal 7 | 1 | TB1-7 | 8.0 | 3 | W/Blue |
| 8 | Terminal 8 | 1 | TB1-8 | 8.0 | 3 | W/Blue |
| 9 | Terminal 11 | 1 | TB2-1 | 11.0 | 3 | W/Brown |
| 10 | Terminal 12 | 1 | TB2-2 | 9.0 | 3 | Violet |
| 11 | Terminal 13 | 1 | TB2-3 | 9.0 | 3 | W/Violet |
| 12 | Terminal 14 | 1 | TB2-4 | 9.0 | 3 | W/Black |
| 13 | Terminal 15 | 1 | TB2-5 | 12.0 | 3 | W/Green |
| 14 | Terminal 18 | 1 | TB2-6 | 11.0 | 3 | W/Grey |
| 15 | Terminal 19 | 1 | TB2-7 | 10.0 | 3 | W/Grey |
| 16 | Terminal 24 | 1 | TB2-8 | 14.0 | 3 | Blue |
| 17 | Terminal 17 | 1 | Terminal 25 | 5.0 | 1 | W/Blue |
| 18 | Terminal 27 | 1 | TB2-8 | 5.0 | 3 | Blue |

NOTES

1. Solder, use Federal Specification QQ-S-571, Sn 60
2. Strip all wires back 0.38 inches.
3. Secure ends with terminal lugs #6 in accordance with MS25036-101.
4. Secure wires with cable straps MS3367-1-9.

## Section VI. MODE I RELAY BOX ASSEMBLY

### 6-77. GENERAL.

The Mode I relay box assembly (A27) is a junction box which is utilized to interconnect certain electronic componentry, for 50/60 hertz precise and utility generator set operation. The relay box contains a DC relay assembly, cross current transformer, a variable resistor, a shorting plug, the engine crank relay (K3), the battery charging ammeter shunt (R13) and interconnecting harnesses.

a. The dc relay assembly (A5) is a component mounted printed circuit board. It contains the field flash relay K5 (figure 1-10), parallel operation voltage sensor rectifier bridge CR4 and relay K7, fuel level relay K8, start circuit diode CR3, fuel pumps diode CR6, and paralleling lights resistors R6 through R9. Resistor R3, rectifier bridge CR4, and relay K7 are connected to output leads T6-T9 of the generator assembly. When the generator output is connected for 120/208 VAC output; T9 is reconnected to T3 and T6 is connected to T12. The voltage across this phase coil is rectified by CR4 and then applied to relay K7. This causes its contacts to close and short out resistors R9 and R6 in series with the synchronizing lights DS4 and DS5. When the generator output voltage is reconnected for 240/416 VAC; terminals T6 and T9 are connected together. This de-energizes relay K7, and resistors R6 and R9 are connected in series with synchronizing lights DS4 and DS5.

b. The variable resistor (R29) is a potentiometer which permits adjustment of reactive KVA between sets operating in parallel. Its slotted shaft, when rotated clockwise, will cause the corresponding set to increase its share of the total reactive KVA.

c. The shorting plug connected to Mode I relay box connector J31 converts the Mode I relay box from precise to utility set operation. Removing this shorting plug allows the precise relay box harness to be connected to J31, thus connecting from utility to precise set operation.

### 6-78. DC RELAY ASSEMBLY (A5).

### 6-79. TEST ON EQUIPMENT.

a. Symptoms and Isolation of Malfunction. A malfunction of the DC relay assembly (A5) is usually indicated by failure of one or more of the following circuits to function normally: the generator field flashing circuit, synchronizing lights circuit, engine fuel pump circuit, engine cranking circuit, or the low fuel level fault circuit. To isolate the malfunction, refer to figure 1-10 and proceed as follows:

WARNING

Exercise extreme care not to touch electrical connections when working on the electrical components with generator set operating.

NOTE

Remove cover from mode I relay box to gain access to the test points, see figures 6-14 and 6-21.

1. Start engine, as engine comes up to speed, measure voltage across terminals

A5-1 and A5-15 (20-32 VDC), A5-13 and A5-15 (20-32 VDC), and terminals A5-2 and A5-14 (20-32 VDC). If there is no voltage measured at terminals A5-2 to A5-14, replace the A5K5 relay.

2. With the generator set connected for 240/416 volts and operating at rated speed and voltage, the voltage measured across terminals A5-18 and A5-22 should be 0 volts AC. Measure the resistance from terminals A5-19 to A5-20, and terminals A5-7 to A5-8 with an ohm-meter. The meter should read 7.5K ohms. If the above measurement is 2.5K ohms, replace the A5K7 relay. If resistance is infinite, replace whichever resistor measures open.

3. With the generator set connected for 120/208 volts and operating at rated speed and voltage, measure the voltage across terminals A5-18 and A5-22. The nominal voltage should read 120 VAC. Measure resistance from terminal A5-19 to A5-20, and terminals A5-7 to A5-8 with an ohmmeter. The meter should read 2.5K ohms. If the measurements are infinity, replace resistor R7 or R9, if resistance measured is 7.5K ohms, replace relay A5K7.

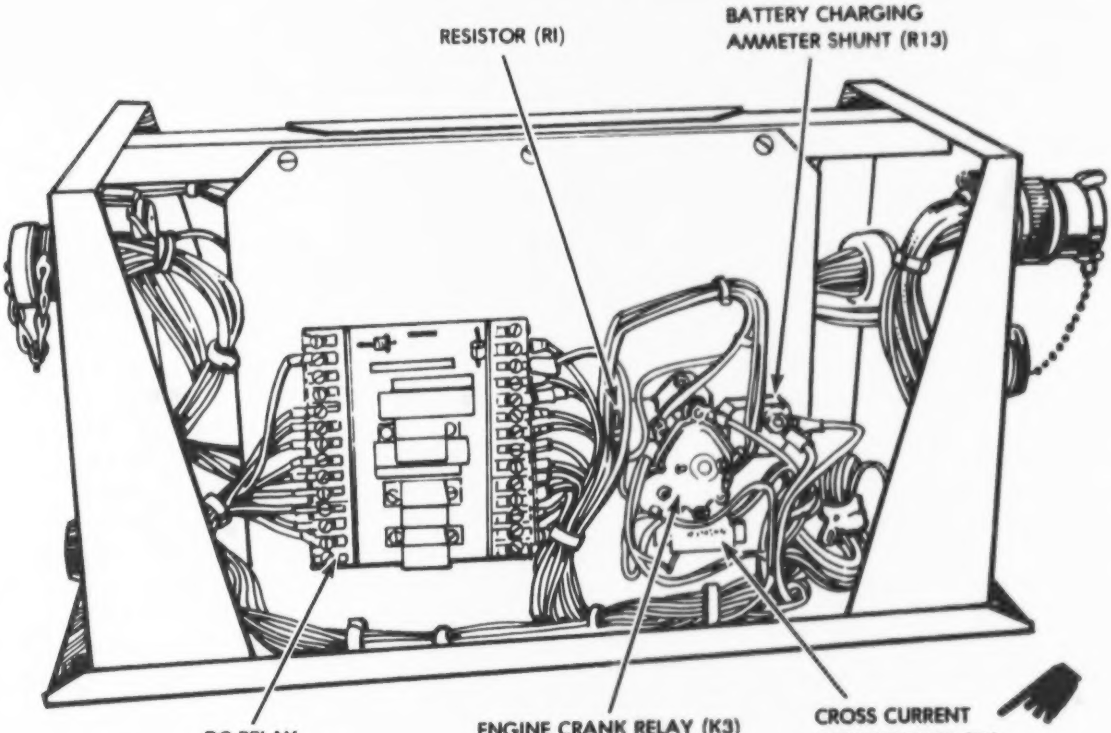

RESISTOR (RI)
BATTERY CHARGING AMMETER SHUNT (R13)
DC RELAY ASSEMBLY (A5)
ENGINE CRANK RELAY (K3)
CROSS CURRENT TRANSFORMER (TI)

Figure 6-21. Mode I relay box assembly (A27), cover removed

4. Place the battle short switch S7 to the ON position and measure the voltage across terminal A5-21 and terminal A5-15. The voltage should read 20-32 VDC when the start-run-stop switch S2 is placed in the run position. Also measure voltage across terminal A5-23 to terminal A5-15. The voltage should read 20-32 VDC. If voltage is measured at A5-21 but not at A5-23, disconnect wire from A5-21 and check for continuity between terminal A5-21 and terminal A5-23 with A5-21 positive. If there is no continuity, replace diode CR6.

5. Measure the voltage across terminal A5-12 to terminal A5-15. The voltage should read 20-32 VDC when the start-run-stop switch S2 is placed in the START position. Also measure voltage across terminal A5-9 to terminal A5-15. The voltage should read 20-32 VDC. If voltage is measured at terminal A5-12 and not at terminal A5-9, disconnect wire from terminal A5-12 and check for continuity across terminals A5-12 to terminal A5-9 with A5-12 positive. If there is no continuity, replace diode CR3.

6. Disconnect connector P33 from the float switch located in the day tank and install a jumper between pins C and D of P33 to simulate a low fuel fault condition. Place the battle short switch S7 in the on position. Place the start-run-stop switch S2 in the RUN position and measure the voltage from terminal A5-6 to terminal A5-15. The voltage should read 20-32 VDC. Disconnect the wire from terminal A5-17 and check continuity across terminal A5-5 to terminal A5-17 with voltage applied to terminal A5-6. If voltage is measured at terminal A5-6 and there is no continuity from terminal A5-5 to terminal A5-17, replace relay A5K8. Remove jumper from pins C and D of P33.

b. Removal. Refer to figure 6-21 and tag, then disconnect wiring to the DC relay terminal board. Remove the four nuts securing the relay in position.

## 6-80. TEST.

a. Connect the DC relay assembly to test equipment as illustrated in figure 6-22 and perform test specified in procedural analysis table 6-8.

NOTE

Figure 1-10 illustrates the DC relay assembly schematic. Refer to this schematic when checking individual components for required values.

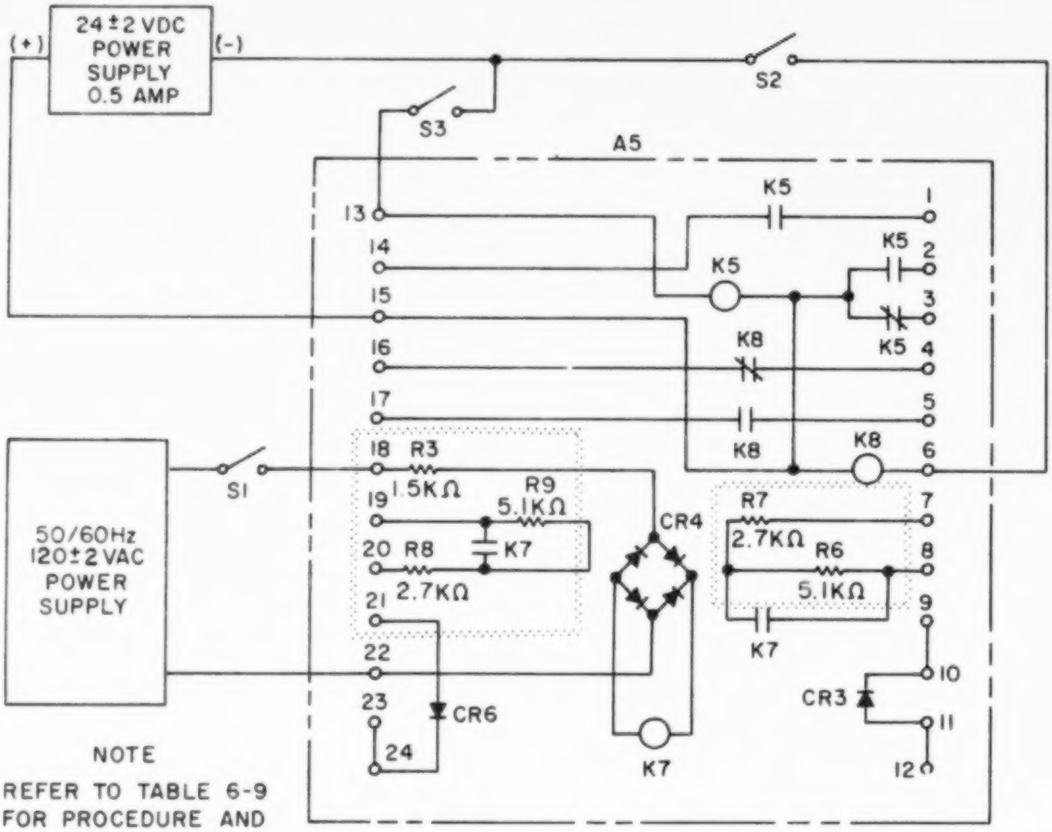
b. Remove the DC relay from the test equipment.

6-81. DISASSEMBLY. Refer to figure 6-23 and disassemble the DC relay assemble to the extent necessary to accomplish repair. Pay particular attention to the following:

a. Exercise care not to apply excessive heat when unsoldering components.

b. Remove relay socket (10) by removing nut (7), lock washer (8) and washer (9). Spacer (11) will fall free.

6-82. CLEANING. Clean all components with a clean lint-free cloth moistened with an approved cleaning solvent and dry thoroughly.


24±2 VDC
POWER
SUPPLY
0.5 AMP
(+)
(-)
S2
S3
A5
K5
K5
K5
K5
K8
K8
K8
13
14
15
16
17
18
19
20
21
22
23
24
1
2
3
4
5
6
7
8
9
10
11
12
S1
50/60Hz
120±2 VAC
POWER
SUPPLY
R3
1.5KΩ
R9
5.1KΩ
R8
2.7KΩ
K7
CR4
R7
2.7KΩ
R6
5.1KΩ
K7
CR3
CR6
K7

NOTE
REFER TO TABLE 6-9
FOR PROCEDURE AND
REQUIRED RESULTS

Figure 6-22. DC relay assembly (A5) test setup

6-83. INSPECTION.

a. Inspect electrical components and printed circuit board in accordance with paragraph 6-71.

b. Inspect relays in accordance with figure 6-5.

c. Inspect relay sockets for damage, shorts to case and surrounding pins.

6-84. REPAIR. Repair printed circuit board in accordance with paragraph 6-72, step b.

6-85. REASSEMBLY. Refer to figure 6-23 and reassemble dc relay assembly in reverse order of index numbers assigned. Pay particular attention to the following:

a. Exercise care not to apply excessive heat to components when soldering connections.

b. Press relay (6) into relay socket (10) squarely and secure in position with screw (5).

c. Test dc relay assembly as outlined in paragraph 6-80.

Table 6-8. DC Relay Assembly (A5) Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| | WARNING<br>Exercise extreme care when testing as high voltage present will cause injury to personnel upon contact. | | | |
| | CAUTION<br>When applying 120 VAC voltages for test to the dc relay assembly terminals, insure correct placement of power supply leads. Damage to other components on dc relay assembly could result if leads are inadvertently misplaced. | | | |
| 1. | Connect 120 VAC, 50/60 hertz supply across terminals 18 and 22 of dc relay assembly and close S1 switch. Measure resistance between terminal 7 and 8, and 19 and 20. | Measured resistance should be 2500 ohms for both measurements. | Open or defective resistor R3. | Check resistor with ohmmeter. |
| | | | Defective full wave rectifier bridge CR4. | Check CR4 with ohmmeter. |
| | | | Defective relay K7. | Remove relay K7 from board, and apply 24±2 vdc to pins 2 and 7 of relay. Check continuity across pins 5 and 3, and 6 and 4. If there is no continuity, relay is defective. |
| | | | Defective resistors R7 and R8. | Check resistors with ohmmeter. |

Table 6-8. DC Relay Assembly (A5) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| | NOTE<br>Remove 120 VAC, 0 to 60 hertz supply before this test. | | | |
| 2. | Measure resistance between terminals 19 and 20, and 7 and 8 of dc relay assembly. | Measured resistance should be 7100-8200 ohms for both measurements. | Defective resistors R6, R7, R8 or R9. | Check resistors with ohmmeter. |
| | | | Defective relay K7. | Check continuity across pins 5 and 3, and 6 and 4 of relay K7. If there is continuity in either measurement; relay K7 is defective. |
| 3. | 3.a. Check continuity between terminals 11 and and 10, and 21 and 23. | There should be continuity. | Defective diode CR3 or CR6. | Check continuity with an ohmmeter (+ lead placed on terminals 11 and 21). |
| | 3.b. Perform continuity checks in above except reverse lead of ohmmeter. | There should not be continuity. | Defective diode CR3 or CR6. | Check continuity with an ohmmeter (+ lead placed on terminals 10 and 23). |

Table 6-8. DC Relay Assembly (A5) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 4. | Connect 24 vdc across terminals 6(-) and 15(+) and close S2 switch. | There shouldn't be continuity between terminals 4 and 16, and there should be continuity between terminals 5 and 17. | Defective relay K8. | Remove relay K8 from board, and apply 24±2 vdc to pins 2 and 7 of relay. Check continuity across pins 5 and 3, and 6 and 4. If there is no continuity, relay is defective. |
|  | NOTE<br>Remove 24 vdc once this test is completed. |  |  |  |
| 5. | Connect 24 vdc across terminals 13 and 15 (terminal 15 positive) and close S3 switch. | Measured voltage between terminals 2 and 13 should be 24 vdc, while between terminals 3 and 13 there should be zero volts. Continuity should exist between terminals 1 and 14. | Defective relay K5. | Remove relay K5 from board, and apply 24±2 vdc to pins 2 and 7 of relay. Check continuity across pins 5 and 3, and 6 and 4. If there is no continuity, relay is defective. |

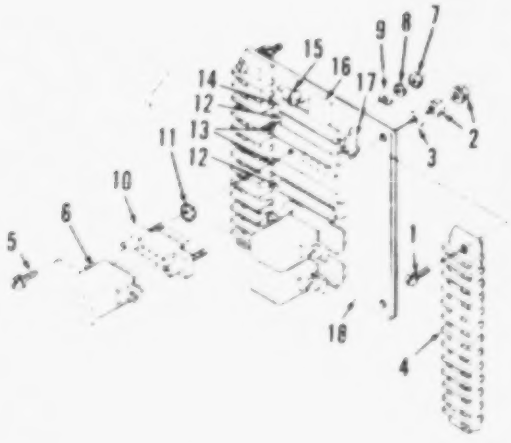


Figure 6-23. DC relay assembly (A5) exploded view

Legend to figure 6-23:

1. Screw (4)
2. Nut assembly (8)
3. Washer (4)
4. Terminal board (2)
5. Screw assembly (6)
6. Relay (3)
7. Nut (6)
8. Lock washer (6)
9. Washer (6)
10. Relay socket (3)
11. Spacer
12. Resistor (2)
13. Resistor (2)
14. Resistor
15. Silicone junction rectifier
16. Silicone bridge rectifier
17. Silicone junction rectifier
18. Board

6-86. INSTALLATION. Refer to figure 6-22 and install the DC relay assembly. Secure the assembly in position with four nuts, then refer to figure 1-11 and reconnect wiring to the relay terminal board. Replace mode I relay box cover.

## 6-87. MODE I RELAY BOX ASSEMBLY (A27).

## 6-88. ON EQUIPMENT TEST.

a. Symptom and Isolation of Malfunction. A malfunction of the mode I relay box assembly is usually indicated by a failure of the DC relay assembly, failure of the engine to crank when the start-run-stop switch S2 is energized, and unequal reactive load sharing when the generator set is operated in parallel. To isolate the malfunction, refer to figure 1-10 and proceed as outlined in steps b. through d.

### WARNING

Exercise extreme care not to touch electrical connections when working on the electrical components with the generator set operating.

b. To isolate a malfunction of the DC relay, refer to paragraph 6-79.

### NOTE

Remove cover from mode I relay box to gain access to the test points, see figures 6-14 and 6-21.

c. To isolate a malfunction of the engine crank relay, place the start-run-stop switch S2 in the START position and measure the voltage across A27K3 relay terminals as follows:

1. Voltage across X1(-) and X2(+) should read 20-32 VDC.

2. Voltage at A1 and A2(+) to A27 TB2-1(-) should read 20-32 VDC.

If the voltage is measured at X1 and A2, but not at A1, replace the relay.

d. To isolate a malfunction in the reactive dropp circuit, install a shorting plug on paralleling receptacle J45, J46 or J47 located below the manual speed control knob. Proceed as follows:

1. With the generator set operating at 100 percent 0.80 PF load, position the parallel switch S6 to the PARALLEL position. Voltage measured across resistor R1 located in this Mode I relay box, as the reactive current rheostat R29, located on the Mode I relay box, is rotated counterclockwise should increase to approximately 9 VAC, then decrease to 0 VAC as R29 is rotated full clockwise. With the generator set operating at 100 percent 0.80 PF load, adjust R29 to obtain 9 VAC across pins C and D of J45 or J47.

2. If the voltage values (step 1 above) are not met, connect a 0-3 amp ammeter in series with current transformer CT7. Current measured should be approximately 1.5 amperes at 100 percent, 0.8 PF load.

3. If the current value (step 2 above) is not met, check continuity of the circuit through current transformer CT7 and reactive current rheostat R29. If the circuitry is proper, check R39 for full resistance range 0-15 ohms.

4. If the current value (step 2 preceeding) is met, measure voltage across terminals of transformer T1. Voltage across terminals 1-2 and 3-4 should be identical, if not, transformer T1 is defective.

d. Removal. Refer to figure 6-14. Disconnect all electrical plug connectors at mode I relay box assembly receptacles, then remove the four screws and nuts securing the assembly in position. Remove the mode I relay box assembly.

### 6-89. BENCH TEST.

a. Refer to table 6-9 and perform a continuity test of mode I relay box circuitry.

b. Connect the mode I relay box assembly to test equipment as illustrated in figure 6-24 and perform test specified in procedural analysis table 6-10.

6-90. DISASSEMBLY. Refer to figures 6-21 and 6-25, and disassemble the mode I relay box assembly in the order of index numbers assigned. Pay particular attention to the following.

NOTE

Disassemble the mode I relay box assembly to the extent necessary to accomplish repair.

a. Remove ten screw assemblies (2, figure 6-25) and washers (3) and left cover (1) from chassis assembly (39).

b. Tag, then disconnect harness wiring from components.

c. Remove battery charging ammeter shunt (R13) engine cranking relay (K3),

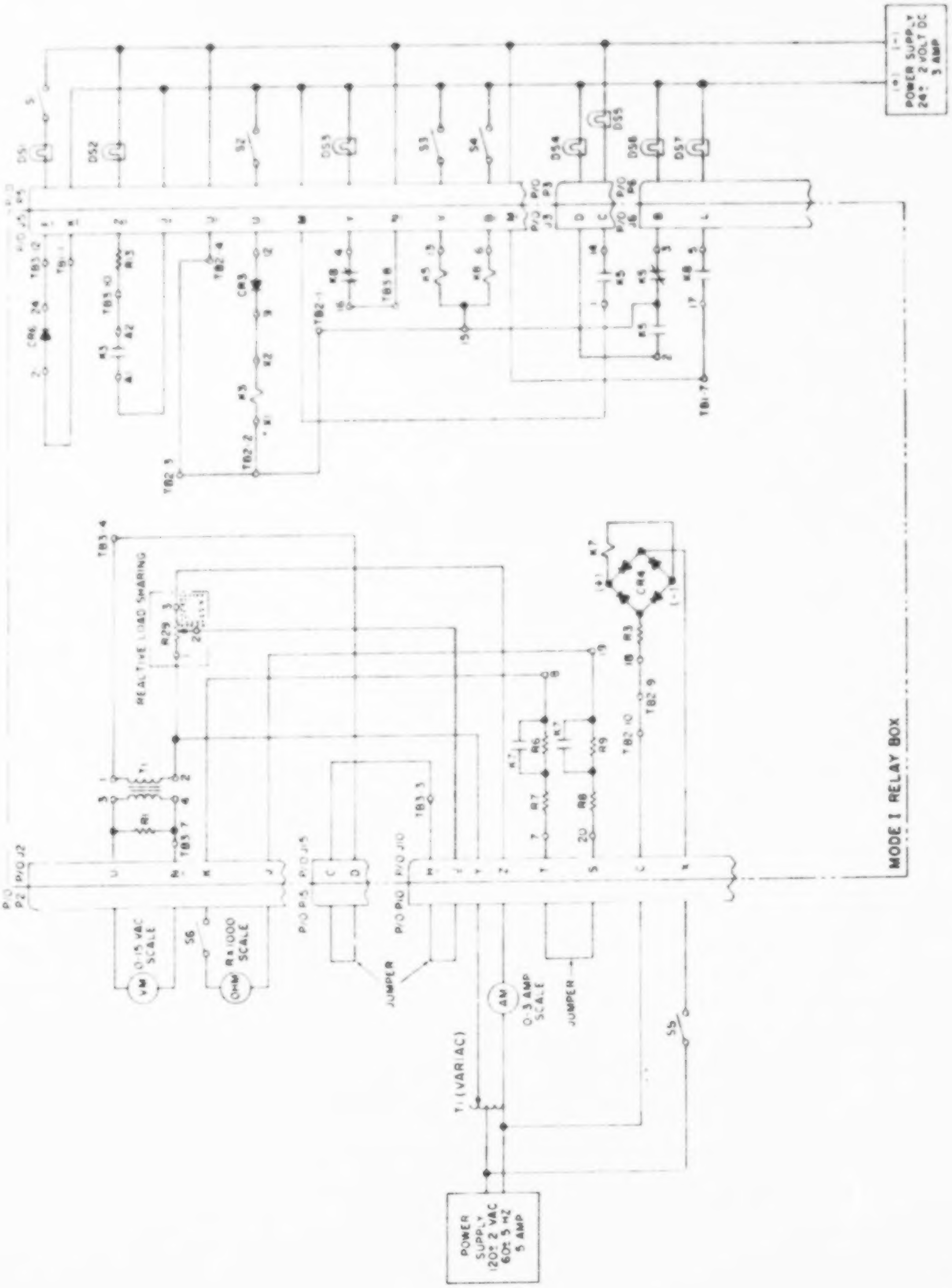

POWER SUPPLY 24± 2 VOLT DC 3 AMP
(+)
(-)
DS1
DS2
DS3
DS4
DS5
DS6
DS7
S1
S2
S3
S4
S5
S6
CR3
CR4
CR6
R3
R7
R8
R9
R29
T1
P/O P5
P/O J5
P/O P3
P/O J3
P/O P6
P/O J6
P/O P2
P/O J2
P/O P15
P/O J15
P/O P10
P/O J10
TB1-7
TB2-1
TB2-2
TB2-3
TB2-4
TB2-9
TB2-10
TB3-3
TB3-4
TB3-7
TB3-8
TB3-10
RELATIVE LOAD SHARING
VM
0-15 VAC SCALE
OHM
R×1000 SCALE
AM
0-3 AMP SCALE
JUMPER
T1 (VARIAC)
MODE I RELAY BOX
POWER SUPPLY 120± 2 VAC 60± 5 HZ 5 AMP

Figure 6-24. Mode I relay box assembly (A27) test setup

Table 6-9. Mode I Relay Box Assembly (A27) Continuity Test

| FROM | TO | REQUIRED RESULT |
|---|---|---|
| J50-L | J50-B | Continuity |
| J50-L | J2-W | Continuity |
| J50-L | J31-E | Continuity |
| J50-L | J10-N | Continuity |
| J50-L | J10-E | Continuity |
| J50-L | J5-K | Continuity |
| J50-L | J5-C | Continuity |
| J50-L | J5-E | Continuity |
| J50-L | A5-21 | Continuity |
| J50-P | J31-K | Continuity |
| J50-P | J6-C | Continuity |
| J50-P | J5-M | Continuity |
| J50-P | J5-Z | Continuity |
| J50-P | J5-W | Continuity |
| J50-P | A5-17 | Continuity |
| J50-R | J2-F | Continuity |
| J50-R | J10-B | Continuity |
| J50-S | J2-E | Continuity |
| J50-S | J10-A | Continuity |
| J50-H | J50-B | Continuity |
| J50-H | J2-H | Continuity |
| J50-W | J2-P | Continuity |
| J50-W | J2-R | Continuity |
| J50-W | J50-M | Continuity |
| J50-W | J31-D | Continuity |
| J50-W | J31-Z | Continuity |
| J50-W | J7-A | Continuity |
| J50-W | J10-L | Continuity |
| J50-W | J29-E | Continuity |
| J50-W | J5-T | Continuity |
| J50-W | J5-U | Continuity |
| J50-W | J5-H | Continuity |
| J50-W | J5-G | Continuity |
| J50-W | J5-S | Continuity |
| J50-W | K3-X1 | Continuity |
| J50-W | A5-15 | Continuity |

Table 6-9. Mode I Relay Box Assembly (A27) Continuity Test (Continued)

| FROM | TO | REQUIRED RESULT |
|---|---|---|
| J50-J | J31-A | Continuity |
| J50-J | J2-$\underline{Z}$ | Continuity |
| J50-J | J10-C | Continuity |
| J50-J | A5-18 | Continuity |
| J50-K | J31-B | Continuity |
| J50-K | J10-W | Continuity |
| J50-K | J2-$\underline{Y}$ | Continuity |
| J50-$\underline{D}$ | J2-D | Continuity |
| J50-V | J10-D | Continuity |
| J50-U | J10-E | Continuity |
| J50-T | J10-F | Continuity |
| J50-$\underline{A}$ | J10-M | Continuity |
| J50-E | J31-L | Continuity |
| J50-X | J31-U | Continuity |
| J50-N | J31-S | Continuity |
| J2-$\underline{T}$ | J31-H | Continuity |
| J2-H | J31-R | Continuity |
| J2-H | J10-$\underline{B}$ | Continuity |
| J2-L | J3-A | Continuity |
| J2-M | J31-M | Continuity |
| J2-N | J31-N | Continuity |
| J2-T | J31-T | Continuity |
| J2-$\underline{B}$ | J31-P | Continuity |
| J2-$\underline{C}$ | J5-G | Continuity |
| J2-$\underline{X}$ | J5-H | Continuity |
| J2-V | J5-I | Continuity |
| J2-W | J5-J | Continuity |
| J2-X | J5-K | Continuity |
| J2-Y | J5-$\underline{Z}$ | Continuity |
| J2-Y | J7-E | Continuity |
| J2-Z | *R13-3 | Continuity |
| J2-P | T1-2 | Continuity |
| J2-S | J29-B | Continuity |
| J2-U | *R1-2 | Continuity |
| J2-A | J10-J | Continuity |
| J2-B | J10-H | Continuity |
| J2-C | J10-G | Continuity |

*Isolation of wire required for proper reading.

Table 6-9. Mode I Relay Box Assembly (A27) Continuity Test (Continued)

| FROM | TO | REQUIRED RESULT |
|---|---|---|
| J2-G | J10-A | Continuity |
| J2-I | J10-D | Continuity |
| J2-J | A5-19 | Continuity |
| J2-K | A5-8 | Continuity |
| J2-O | J29-C | Continuity |
| J2-A | J10-F | Continuity |
| J2-U | J29-A | Continuity |
| J2-V | A5-1 | Continuity |
| J2-K | J29-H | Continuity |
| J2-K | J10-C | Continuity |
| J2-M | J5-P | Continuity |
| J2-M | J5-P | Continuity |
| J2-M | J5-R | Continuity |
| J2-N | R1-1 | Continuity |
| J2-N | J3-B | Continuity |
| J2-E | J29-F | Continuity |
| J2-E | A5-16 | Continuity |
| J2-E | J5-N | Continuity |
| J2-G | J5-D | Continuity |
| J2-G | J29-G | Continuity |
| J2-R | J6-A | Continuity |
| J2-R | J29-D | Continuity |
| J50-C | J6-I | Continuity |
| J50-D | J6-H | Continuity |
| J50-F | J6-F | Continuity |
| J50-G | J6-M | Continuity |
| J50-A | J5-E | Continuity |
| J5-F | J31-C | Continuity |
| J5-J | K3-A1 | Continuity |
| J5-W | *R13-4 | Continuity |
| J5-W | K3-A2 | Continuity |
| J5-W | J5-L | Continuity |

*Isolation of wire required for proper reading.

Table 6-9. Mode I Relay Box Assembly (A27) Continuity Test (Continued)

| FROM | TO | REQUIRED RESULT |
|---|---|---|
| J5-$\underline{D}$ | J5-$\underline{F}$ | Continuity |
| J5-$\underline{D}$ | A5-24 | Continuity |
| | | |
| J5-A | J6-K | Continuity |
| J5-B | J6-E | Continuity |
| J5-C | J6-D | Continuity |
| J5-$\underline{Z}$ | *R13-1 | Continuity |
| J5-M | A5-1 | Continuity |
| J5-U | A5-12 | Continuity |
| J5-V | A5-13 | Continuity |
| J5-Y | A5-4 | Continuity |
| J5-$\underline{B}$ | A5-6 | Continuity |
| | | |
| J15-J | J15-E | Continuity |
| J15-J | J15-A | Continuity |
| J15-J | J10-$\underline{G}$ | Continuity |
| J15-F | J31-J | Continuity |
| J15-F | J15-K | Continuity |
| J15-F | J15-B | Continuity |
| | | |
| J15-L | J15-G | Continuity |
| J15-L | J15-C | Continuity |
| J15-L | J10-$\underline{H}$ | Continuity |
| | | |
| J15-M | J15-H | Continuity |
| J15-M | J15-D | Continuity |
| J15-M | T1-1 | Continuity |
| | | |
| J10-K | J31-G | Continuity |
| J10-$\underline{J}$ | R29-2 | Continuity |
| J10-X | A5-22 | Continuity |
| J10-Y | R29-1 | Continuity |
| J10-Z | R29-3 | Continuity |
| J10-T | A5-7 | Continuity |
| J10-S | A5-20 | Continuity |
| | | |
| J3-C | A5-14 | Continuity |
| J8-D | A5-2 | Continuity |
| J31-F | J6-G | Continuity |
| J6-B | A5-3 | Continuity |
| J6-L | A5-5 | Continuity |
| R1-1 | T1-4 | Continuity |
| R1-2 | T1-3 | Continuity |

*Isolation of wire required for proper reading.

Table 6-10. Mode I Relay Assembly (A27) Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 1. | Connect mode I relay box assembly to test equipment depicted in figure 6-24 and open all switches. | | | |
| 2. | Energize the 24 VDC power source. | Indicator lights DS3 and DS6 should light. | Defective relays K5 and K8 | Test relays as outlined in figure 6-5. |
| 3. | Close switch S1. | Indicator light DS1 should light. | Defective diode CR6. | Check diode. |
| 4. | Close switch S2. | Indicator light DS2 should light. | Defective relay K3, resistor R13, or diode CR3. | Test relay as outlined in figure 6-5. Check diode and resistor. |
| 5. | Close switch S3. | Indicator light DS6 should extinguish and DS4 and DS5 should light. | Defective relay K5. | Test relay as outlined in figure 6-5. |
| 6. | Close switch S4. | Indicator light DS3 should extinguish and DS7 should light. | Defective relay K8. | Test relay as outlined in figure 6-5. |

Table 6-10. Mode I Relay Assembly (A27) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 7. | Turn on AC power supply and close switches S5 and S6. | Ohmmeter should read 5K ohms. | Defective relay K7. Open resistors R7 or R8. | Test relay as outlined in figure 6-5. Check resistors. |
| 8. | With switch S6 closed, open S5. | Ohmmeter should read 15K ohms. | Defective relay K7. Open resistors R6 or R9. | Test relay as outlined in figure 6-5. Check resistors. |
| 9. | Adjust transformer T1 so that ammeter reads 1.5 ± 0.1 amperes. | Voltmeter shall indicate 0-7.4 ±0.2 VAC as reactive load sharing rheostat R29 is varied full range. | Defective resistor R1, transformer T1 or rheostat R29. | Check resistor, transformer and rheostat. |
| 10. | Turn off AC and DC power supplies. | | | |

transformer (T1) and resistor (R1) by removing their attaching screws and nuts (2 each). See figure 6-21.

d. Remove dc control relay assembly (A5) by removing the four nuts securing the assembly in position.

NOTE

Refer to paragraph 6-78 for dc relay assembly maintenance instructions.

e. Remove nut (4, figure 6-25) and washer (5) securing rheostat (6) to chassis assembly (39).

f. Remove wire harness (25) by removing the four screws and nuts securing each of the ten connectors to the chassis assembly (39).

NOTE

Electrical connector covers (7 and 8) will fall free.

6-91. CLEANING. Clean all components with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

6-92. INSPECTION AND BENCH TEST.

a. Harness.

1. Inspect harness wiring for defective insulation and continuity.

2. Inspect harness connectors for damaged threads; bent, loose or missing pins and for shorts.

b. Test transformer T1 by applying 9 VAC, to terminals 1 and 2. (Excitation current shall be less than 0.1 ampere.) Output measured at terminals 3 and 4 shall be 9 VAC.

c. Test engine cranking relay K3 by applying 24 VDC to terminals X1 and X2. Normally open contacts A1-A2 shall close.

6-93. REPAIR.

a. Repair or fabricate mode I relay box assembly wiring harness according to figure 6-26.

b. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with a suitable abrasive paper and touch up painted surfaces. Restencil panel markings as necessary.

6-94. REASSEMBLY. Refer to figure 6-25 and reassemble the mode I relay box assembly in reverse order of index numbers assigned. Pay particular attention to the following:

a. Assemble battery charging ammeter shunt (R13), engine cranking relay (K3), transformer (T1), and resistor (R1) in position using two each, screws and nuts. See figure 6-21.

b. Assemble DC control relay assembly (A5) in position using four nuts.

c. Install wire harness (25, figure 6-25) in chassis (39) and secure in position with four screws and nuts at each of the ten connectors.

d. Connect wire harness leads to componentry using figure 1-11 as a guide.

NOTE

Solder connections shall be made using solder, Federal Specification QQ-S-571, Sn 60.

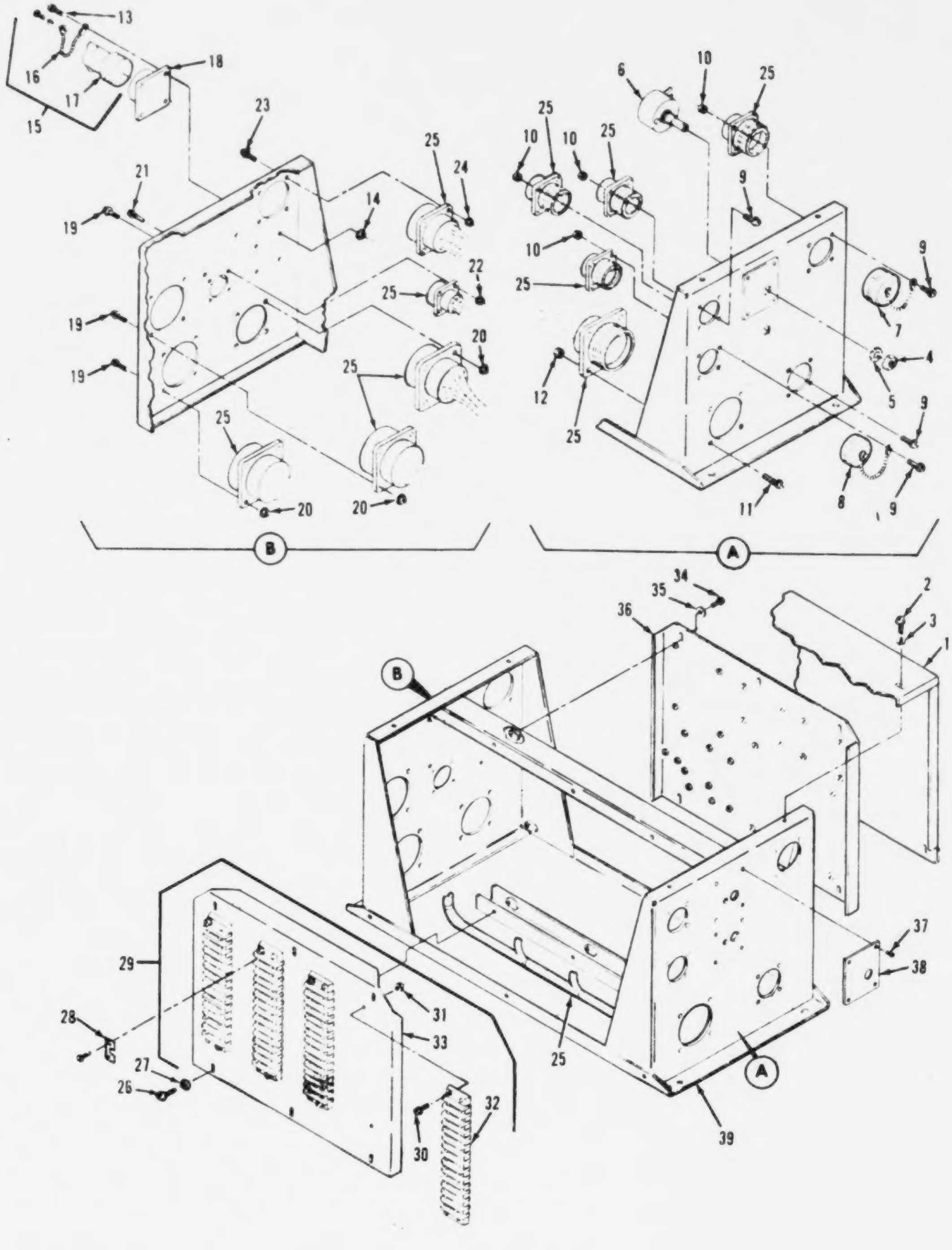

13
18
16
17
15
23
21
19
14
25
24
22
25
20
19
19
25
25
20
20
B
6
10
25
25
10
10
25
9
10
25
9
7
4
5
12
25
9
11
8
9
A
34
35
36
2
3
1
B
37
38
29
31
33
28
27
26
25
A
32
30
39

Figure 6-25. Mode I relay box assembly (A-27), exploded view

Legend to figure 6-25:

1. Cover
2. Screw assembly (10)
3. Washer (10)
4. Nut
5. Washer
6. Rheostat (R29)
7. Electrical connector cover
8. Electrical connector cover
9. Screw assembly (16)
10. Nut assembly (16)
11. Screw assembly (4)
12. Nut assembly (4)
13. Screw assembly (4)
14. Nut assembly (5)
15. Connector assembly
16. Chain assembly
17. Connector
18. Dummy connector
19. Screw assembly (8)
20. Nut assembly (8)
21. Screw assembly (8)
22. Nut assembly (8)
23. Screw assembly (8)
24. Nut assembly (8)
25. Wire harness
26. Screw assembly
27. Washer
28. Jumper terminal board
29. Terminal board assembly
30. Screw assembly (8)
31. Nut assembly (8)
32. Terminal board (4)
33. Bracket
34. Screw assembly (6)
35. Washer (6)
36. Electronic component assembly
37. Rivet (4)
38. Identification plate
39. Chassis assembly

e. Test mode I relay box assembly as outlined in paragraph 6-89.

f. Secure cover (1, figure 6-25) to chassis assembly (39) using ten screw assemblies (2) and washers (3).

6-95. INSTALLATION. Refer to figure 6-14, and install the mode I relay box assembly. Secure the assembly in position using four screws and nuts. Refer to the Operator and Organizational Maintenance Manual and reconnect all electrical plug connectors to the assembly receptacles.

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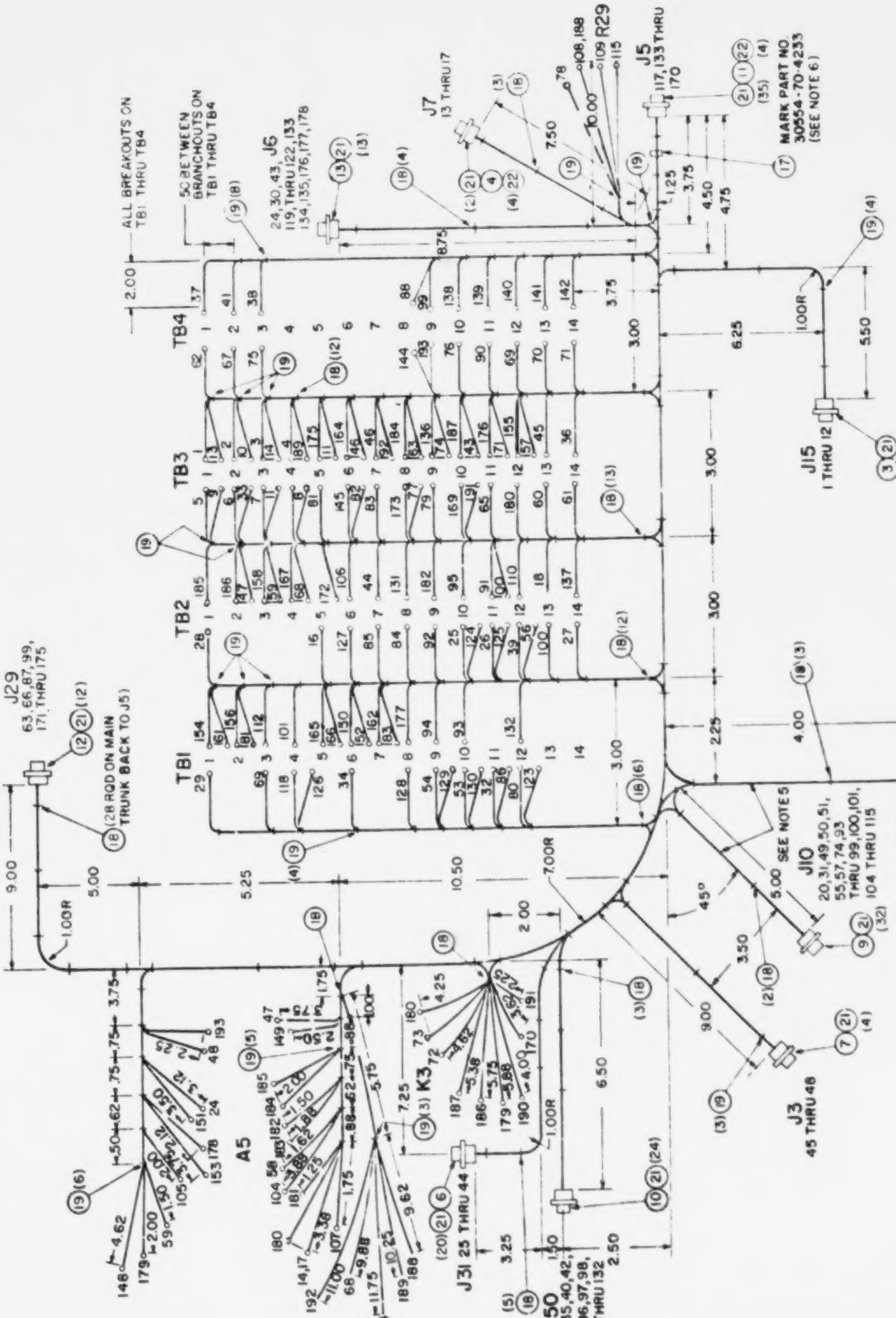
ALL BREAKOUTS ON TB1 THRU TB4
.50 BETWEEN BRANCHOUTS ON TB1 THRU TB4
J6
24,30,43, 119,THRU 122,133 134,135,176,177,178
J7
13 THRU 17
R29
108,188
109
115
78
J5
117,133 THRU 170
MARK PART NO. 30554-70-4233 (SEE NOTE 6)
TB1
TB2
TB3
TB4
J15
1 THRU 12
J29
63,66,87,99, 171, THRU 175
(28 RQD ON MAIN TRUNK BACK TO J5)
J10
20,31,49,50,51, 55,57,74,93 THRU 99,100,101, 104 THRU 115
SEE NOTE 5
J2
49 THRU 92
J3
45 THRU 48
K3
A5
J31
25 THRU 44
J50
20,35,40,42, 52,96,97,98, 117 THRU 132
1.00R
7.00R
45°

Figure 6-26. Mode I relay box wiring harness (Sheet 1 of 4)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24 | | B | 71-4924 | 10 | TERMINAL, LUG, CRIMP STYLE | NOTE 9 | |
| 23 | | | MS25036-108 | 4 | TERMINAL, LUG, CRIMP STYLE | | |
| 22 | | | TYPE F, FORM Ua<br>GRADE a, CL I<br>CATEGORY 1 | 8 | TUBING, INSULATION<br>.166 ID X .020 WALL X .62 LG | MIL-I-631 | |
| 21 | | | TYPE F, FORM Ua<br>GRADE a, CL I<br>CATEGORY 1 | 198 | TUBING, INSULATION<br>.106 ID X .016 WALL X .62 LG | MIL-I-631 | |
| 20 | | | SN60WRAP2 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 19 | | | MS3367-4-9 | 40 | STRAP, TIEDOWN | | NYLON |
| 18 | | | MS3367-1-9 | 91 | STRAP, TIEDOWN | | NYLON |
| 17 | | | MS39020-4 | 1 | BAND, MARKER | | AL ALY |
| 16 | | | MS25036-157 | 3 | TERMINAL, LUG, CRIMP STYLE | | |
| 15 | | | MS25036-111 | 3 | TERMINAL, LUG, CRIMP STYLE | | |
| 14 | | | MS25036-106 | 140 | TERMINAL, LUG, CRIMP STYLE | | |
| 13 | | | MS3102R20-27S | 1 | CONNECTOR, RECEPTACLE | | |
| 12 | | | MS3102R22-19S | 1 | CONNECTOR, RECEPTACLE | | |
| 11 | | | MS3102R36-7P | 1 | CONNECTOR, RECEPTACLE | | |
| 10 | | | MS3102R28-12S | 1 | CONNECTOR, RECEPTACLE | | |
| 9 | | | MS3102R32-7P | 1 | CONNECTOR, RECEPTACLE | | |
| 8 | | | MS3102R36-7S | 1 | CONNECTOR, RECEPTACLE | | |
| 7 | | | MS3102R14S-6S | 1 | CONNECTOR, RECEPTACLE | | |
| 6 | | | MS3102R24-28S | 1 | CONNECTOR, RECEPTACLE | | |
| 5 | | | | | | | |
| 4 | | | MS3102R28-20S | 1 | CONNECTOR, RECEPTACLE | | |
| 3 | | | MS3102R20-29S | 1 | CONNECTOR, RECEPTACLE | | |
| 2 | | | M5086/2-12-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| FIND NO. | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |

LIST OF MATERIAL

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 20. SOLDER CONNECTIONS PER MIL-STD-454, REQT 5.
3. CABLE STRAPS, FIND NO. 18 AND 19, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. BRANCHOUTS TO FIND NO. 5(J52), FIND NO. 9 (J10) AND FIND NO 8, (J2) SHALL BE LAID OUT IN THAT RESPECTIVE ORDER.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

Figure 6-26. Mode I relay box wiring harness (Sheet 2 of 4)

| WIRE NO | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | K112D16 | J15-A | 3 | TB3-1 | 14 | 25.00 |
| 2 | BLACK | K111E16 | J15-B | ↑ | TB3-2 | 14 | 24.50 |
| 3 | BLACK | X98D16 | J15-C | | TB3-3 | 14 | 24.00 |
| 4 | BLACK | X96B16 | J15-D | | TB3-4 | 14 | 23.50 |
| 5 | BLACK | K112F16 | J15-E | | TB3-1 | 14 | 25.00 |
| 6 | BLACK | K111H16 | J15-F | | TB3-2 | 14 | 24.50 |
| 7 | BLACK | X98F16 | J15-G | | TB3-3 | 14 | 24.00 |
| 8 | BLACK | X96D16 | J15-H | | TB3-4 | 14 | 23.50 |
| 9 | BLACK | K112J16 | J15-J | | TB3-1 | 14 | 25.00 |
| 10 | BLACK | K111K16 | J15-K | | TB3-2 | 14 | 24.50 |
| 11 | BLACK | X98J16 | J15-L | ↓ | TB3-3 | 14 | 24.00 |
| 12 | BLACK | X96F16 | J15-M | 3 | TB3-4 | 14 | 23.50 |
| 13 | BLACK | P55PP12 | J7-A | 4 | TB2-6 | 24 | 22.00 |
| 14 | BLACK | P51A12 | J7-B | ↑ | A5-25 | 15 | 41.00 |
| 15 | BLACK | P141D12 | J7-E | | TB2-13 | 24 | 19.50 |
| 16 | BLACK | P55AP12 | J7-F | | TB2-5 | 24 | 29.00 |
| 17 | BLACK | P51N12 | J7-G | ↓ | A5-23 | 15 | 48.00 |
| 18 | BLACK | P141H12 | J7-P | 4 | TB2-13 | 24 | 19.50 |
| 19 | | | | | | | |
| 20 | BLACK | P63C16 | J50-a | 5 | J10-M | 9 | |
| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |
| 24 | BLACK | P66B16 | A5-3 | 5 | J6-B | 13 | |
| 25 | BLACK | X9C16 | J31-A | 5 | TB2-10 | 14 | 26.00 |
| 26 | BLACK | X12A16 | J31-B | ↑ | TB2-11 | 14 | 25.00 |
| 27 | BLACK | P81F16 | J31-C | | TB2-14 | 14 | 25.00 |
| 28 | BLACK | P55AB16 | J31-D | | TB2-1 | 14 | 29.50 |
| 29 | BLACK | P50L16 | J31-E | | TB1-1 | 14 | 25.00 |
| 30 | BLACK | P204B16 | J31-F | | J6-G | 13 | 40.00 |
| 31 | BLACK | K110D16 | J31-G | | J10-K | 9 | 23.50 |
| 32 | BLACK | P57F16 | J31-H | | TB1-11 | 14 | 21.00 |
| 33 | BLACK | K111D16 | J31-J | | TB3-2 | 14 | 32.50 |
| 34 | BLACK | P200C16 | J31-K | | TB1-6 | 14 | 23.00 |
| 35 | BLACK | P60C16 | J31-L | | J50-E | 10 | 18.50 |
| 36 | BLACK | K32H16 | J31-M | | TB3-14 | 14 | 39.00 |
| 37 | BLACK | K33F16 | J31-N | | TB4-1 | 14 | 39.00 |
| 38 | BLACK | L93H16 | J31-P | | TB4-3 | 14 | 39.00 |
| 39 | BLACK | X15J16 | J31-R | | TB2-12 | 14 | 24.50 |
| 40 | BLACK | K102F16 | J31-S | | J50-N | 10 | 18.50 |
| 41 | BLACK | K34F16 | J31-T | | TB4-2 | 14 | 39.00 |
| 42 | BLACK | K101F16 | J31-U | | J50-X | 10 | 18.50 |
| 43 | BLACK | P210B16 | J31-V | ↓ | J5-N | 13 | 40.00 |
| 44 | BLACK | P55AS16 | J31-Z | 6 | TB2-7 | 14 | 30.50 |
| 45 | BLACK | X91F16 | J3-A | 7 | TB3-13 | 14 | 19.00 |
| 46 | BLACK | X197F16 | J3-B | 7 | TB3-7 | 14 | 28.00 |
| 47 | BLACK | P42A16 | J3-C | 7 | A5-14 | 14 | 23.50 |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 48 | BLACK | P67A16 | J3-D | 7 | A5-2 | 14 | 31.00 |
| 49 | BLACK | D20D16 | J2-A | 8 | J10-J | 9 | 13.50 |
| 50 | BLACK | D21D16 | J2-B | ↑ | J10-H | 9 | 13.50 |
| 51 | BLACK | D22D16 | J2-C | | J10-G | 9 | 13.50 |
| 52 | BLACK | D24D16 | J2-D | | J50-d | 10 | 21.00 |
| 53 | BLACK | X7B16 | J2-E | | TB1-10 | 14 | 14.50 |
| 54 | BLACK | X8B16 | J2-F | | TB1-9 | 14 | 15.00 |
| 55 | BLACK | X14B16 | J2-G | | J10-a | 9 | 13.50 |
| 56 | BLACK | X15B16 | J2-H | | TB2-12 | 14 | 14.00 |
| 57 | BLACK | X16B16 | J2-I | | J10-c | 9 | 13.50 |
| 58 | BLACK | L25C16 | J2-J | | A5-19 | 14 | 27.00 |
| 59 | BLACK | L26C16 | J2-K | | A5-8 | 14 | 33.00 |
| 60 | BLACK | X91C16 | J2-L | | TB3-13 | 14 | 17.00 |
| 61 | BLACK | K32C16 | J2-M | | TB3-14 | 14 | 15.00 |
| 62 | BLACK | K33C16 | J2-N | | TB4-1 | 14 | 25.50 |
| 63 | BLACK | X31C16 | J2-O | | J29-C | 12 | 41.00 |
| 64 | BLACK | X194C16 | J2-P | | T1-2 | 14 | 38.50 |
| 65 | BLACK | P45H16 | J2-R | | TB3-11 | 14 | 17.00 |
| 66 | BLACK | X29C16 | J2-S | | J29-B | 12 | 41.00 |
| 67 | BLACK | K34C16 | J2-T | | TB4-2 | 14 | 24.75 |
| 68 | BLACK | X90D16 | J2-U | | R1-2 | — | 37.00 |
| 69 | BLACK | E39C16 | J2-V | | TB4-12 | 14 | 19.50 |
| 70 | BLACK | E38C16 | J2-W | | TB4-13 | 14 | 19.00 |
| 71 | BLACK | E37C16 | J2-X | | TB4-14 | 14 | 18.50 |
| 72 | BLACK | E35C16 | J2-Y | | R13-2 | 23 | 21.00 |
| 73 | BLACK | E36C16 | J2-Z | | R13-3 | 23 | 20.50 |
| 74 | BLACK | P199C16 | J2-a | | J10-f | 9 | 13.50 |
| 75 | BLACK | L93D16 | J2-b | | TB4-3 | 14 | 24.00 |
| 76 | BLACK | P198C16 | J2-c | | TB4-10 | 14 | 20.50 |
| 77 | BLACK | P47D16 | J2-e | | TB3-8 | 14 | 17.50 |
| 78 | BLACK | X195C16 | J2-f | | R29-3 | — | 28.50 |
| 79 | BLACK | P44D16 | J2-g | | TB3-9 | 14 | 17.50 |
| 80 | BLACK | P62B16 | J2-h | | TB1-12 | 14 | 13.50 |
| 81 | BLACK | P56D16 | J2-k | | TB3-5 | 14 | 19.00 |
| 82 | BLACK | P80C16 | J2-m | | TB3-6 | 14 | 18.50 |
| 83 | BLACK | X197C16 | J2-n | | TB3-7 | 14 | 18.00 |
| 84 | BLACK | P557Z16 | J2-p | | TB2-8 | 14 | 16.50 |
| 85 | BLACK | P55W16 | J2-r | | TB2-7 | 14 | 17.00 |
| 86 | BLACK | P57E16 | J2-t | | TB1-11 | 14 | 14 00 |
| 87 | BLACK | P40K16 | J2-u | | J29-A | 12 | 41.00 |
| 88 | BLACK | P46J16 | J2-v | | TB4-9 | 14 | 29.00 |
| 89 | BLACK | P50K16 | J2-w | | TB1-3 | 14 | 18.50 |
| 90 | BLACK | P46C16 | J2-x | | TB4-11 | 14 | 20.00 |
| 91 | BLACK | X12B16 | J2-y | ↓ | TB2-11 | 14 | 16.50 |
| 92 | BLACK | X9B16 | J2-z | 8 | TB2-9 | 14 | 16.00 |
| 93 | BLACK | X7A16 | J10-A | 9 | TB1-10 | 14 | 16.00 |
| 94 | BLACK | X8A16 | J10-B | 9 | TB1-9 | 14 | 16.50 |

Figure 6-26. Mode I relay box wiring harness (Sheet 3 of 4)

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 95 | BLACK | X9A16 | J10-C | 9 | TB2-10 | 14 | 18.50 |
| 96 | BLACK | X19C16 | J10-D | ↑ | J50-V | 10 | 18.50 |
| 97 | BLACK | X18C16 | J10-E | | J50-U | 10 | 19.00 |
| 98 | BLACK | X17C16 | J10-F | | J50-T | 10 | 19.00 |
| 99 | BLACK | P40AB16 | J10-V | | TB4-9 | 14 | 30.00 |
| 100 | BLACK | P55J16 | J10-L | ↓ | TB2-6 | 14 | 20.00 |
| 101 | BLACK | P50EE16 | J10-N | 9 | TB1-4 | 14 | 18.50 |
| 102 | | | | | | | |
| 103 | | | | | | | |
| 104 | BLACK | X21R16 | J10-S | 9 | A5-20 | 14 | 25.50 |
| 105 | BLACK | X22R16 | J10-T | ↑ | A5-7 | 14 | 33.50 |
| 106 | BLACK | X12W16 | J10-W | | TB2-11 | 14 | 17.50 |
| 107 | BLACK | X6C16 | J10-X | | A5-22 | 14 | 26.00 |
| 108 | BLACK | X194E16 | J10-Y | | R29-1 | — | 29.00 |
| 109 | BLACK | X195D16 | J10-Z | | R29-3 | — | 29.00 |
| 110 | BLACK | X15A16 | J10-b | | TB2-12 | 14 | 18.00 |
| 111 | BLACK | P56H16 | J10-c | | TB3-5 | 14 | 23.00 |
| 112 | BLACK | P50MM16 | J10-e | | TB1-3 | 14 | 19.00 |
| 113 | BLACK | K112C16 | J10-[illegible] | | TB3-1 | 14 | 25.00 |
| 114 | BLACK | X98C16 | J10-h | ↓ | TB3-3 | 14 | 23.50 |
| 115 | BLACK | X97A16 | J10-j | 9 | R29-2 | — | 32.00 |
| 116 | | | | | | | |
| 117 | BLACK | P58B16 | J50-A | 10 | J5-E | 14 | 28.00 |
| 118 | BLACK | P50R16 | J50-B | ↑ | TB1-4 | 14 | 20.00 |
| 119 | BLACK | P206B16 | J50-C | | J6-1 | 13 | 36.00 |
| 120 | BLACK | P205B16 | J50-D | | J6-H | 13 | 36.00 |
| 121 | BLACK | P203B16 | J50-F | | J6-F | 13 | 36.00 |
| 122 | BLACK | P209B16 | J50-G | | J6-M | 13 | 36.00 |
| 123 | BLACK | P62H16 | J50-H | | TB1-12 | 14 | 16.50 |
| 124 | BLACK | X9T16 | J50-J | | TB2-10 | 14 | 21.50 |
| 125 | BLACK | X12AA16 | J50-K | | TB2-11 | 14 | 21.50 |
| 126 | BLACK | P50Z16 | J50-L | | TB1-4 | 14 | 19.00 |
| 127 | BLACK | P55Y16 | J50-M | | TB2-6 | 14 | 23.50 |
| 128 | BLACK | P203S16 | J50-P | | TB1-8 | 14 | 18.00 |
| 129 | BLACK | X8H16 | J50-R | | TB1-9 | 14 | 17.00 |
| 130 | BLACK | X7H16 | J50-S | | TB1-10 | 14 | 16.50 |
| 131 | BLACK | P55AR16 | J50-W | ↓ | TB2-8 | 14 | 25.00 |
| 132 | BLACK | P62A16 | J50-b | 10 | TB1-12 | 14 | 21.00 |
| 133 | BLACK | P207B16 | J5-A | 11 | J6-K | 13 | 15.00 |
| 134 | BLACK | P202B16 | J5-B | ↑ | J6-E | 13 | 15.00 |
| 135 | BLACK | P201B16 | J5-C | | J6-D | 13 | 15.00 |
| 136 | BLACK | P44H16 | J5-D | | TB3-9 | 14 | 14.00 |
| 137 | BLACK | P81D16 | J5-F | | TB2-14 | 14 | 15.00 |
| 138 | BLACK | P198E16 | J5-G | | TB4-10 | 14 | 10.50 |
| 139 | BLACK | P46E16 | J5-H | | TB4-11 | 14 | 10.00 |
| 140 | BLACK | E39E16 | J5-1 | ↓ | TB4-12 | 14 | 9.50 |
| 141 | BLACK | E38E16 | J5-J | 11 | TB4-13 | 14 | 8.50 |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 142 | BLACK | E37E16 | J5-K | 11 | TB4-14 | 14 | 7.50 |
| 143 | BLACK | P140J16 | J5-L | ↑ | TB3-10 | 14 | 13.50 |
| 144 | BLACK | P40H16 | J5-M | | TB4-9 | 14 | 16.00 |
| 145 | BLACK | P80B16 | J5-P | | TB3-6 | 14 | 17.50 |
| 146 | BLACK | P80F16 | J5-R | | TB3-6 | 14 | 17.50 |
| 147 | BLACK | P55F16 | J5-S | | TB2-2 | 14 | 18.50 |
| 148 | BLACK | P48B16 | J5-U | | A5-12 | 14 | 43.00 |
| 149 | BLACK | P54B16 | J5-V | | A5-13 | 14 | 33.00 |
| 150 | BLACK | P200J16 | J5-W | | TB1-6 | 14 | 20.50 |
| 151 | BLACK | P52B16 | J5-Y | | A5-4 | 14 | 40.00 |
| 152 | BLACK | P200L16 | J5-Z | | TB1-6 | 14 | 21.00 |
| 153 | BLACK | P68R16 | J5-[illegible] | | A5-6 | 14 | 42.00 |
| 154 | BLACK | P50X16 | J5-[illegible] | | TB1-1 | 14 | 23.00 |
| 155 | BLACK | P51D16 | J5-[illegible] | | TB3-12 | 14 | 13.00 |
| 156 | BLACK | P50U16 | J5-[illegible] | | TB1-2 | 14 | 23.00 |
| 157 | BLACK | P51F16 | J5-[illegible] | | TB3-12 | 14 | 13.00 |
| 158 | BLACK | P55S16 | J5-g | | TB2-3 | 14 | 18.25 |
| 159 | BLACK | P55P16 | J5-h | | TB2-3 | 14 | 18.50 |
| 160 | BLACK | P41A16 | J5-[illegible] | | K3-A1 | 23 | 30.00 |
| 161 | BLACK | P50KK16 | J5-k | | TB1-1 | 14 | 23.00 |
| 162 | BLACK | P200P16 | [illegible] | | TB1-7 | 14 | 20.50 |
| 163 | BLACK | P47J16 | [illegible] | | TB3-8 | 14 | 14.00 |
| 164 | BLACK | P80A16 | [illegible] | | TB3-6 | 14 | 15.00 |
| 165 | BLACK | P50RR16 | J5-[illegible] | | TB1-5 | 14 | 22.00 |
| 166 | BLACK | P50TT16 | [illegible] | | [illegible] | 14 | 24.00 |
| 167 | BLACK | P55M12 | J5-[illegible] | | TB2-4 | 24 | 18.00 |
| 168 | BLACK | P55E12 | J5-[illegible] | | TB2-4 | 24 | 18.00 |
| 169 | BLACK | P140E12 | J5-w | ↓ | TB3-10 | 24 | 15.00 |
| 170 | BLACK | P141C12 | J5-[illegible] | 11 | R13-1 | 16 | 51.00 |
| 171 | BLACK | P45L16 | J29-D | 12 | TB3-11 | 14 | 47.00 |
| 172 | BLACK | P55UU16 | J29-E | ↑ | TB2-5 | 14 | 49.00 |
| 173 | BLACK | P47F16 | J29-F | | TB3-8 | 14 | 47.00 |
| 174 | BLACK | P44F16 | J29-G | ↓ | TB3-9 | 14 | 49.00 |
| 175 | BLACK | P56E16 | J29-H | 12 | TB3-5 | 14 | 51.00 |
| 176 | BLACK | P45J16 | J6-A | 13 | TB3-11 | 14 | 20.00 |
| 177 | BLACK | P200B16 | J6-C | 13 | TB1-8 | 14 | 27.00 |
| 178 | BLACK | P208B16 | J6-L | 13 | A5-5 | 14 | 48.50 |
| 179 | BLACK | P49A16 | A5-9 | 14 | K3-X2 | 14 | 24.50 |
| 180 | BLACK | P51C16 | A5-24 | 14 | TB3-12 | 14 | 30.0 |
| 181 | BLACK | P50JJ16 | A5-2 | [illegible] | TB1-2 | 24 | 30.50 |
| 182 | BLACK | X9J16 | A5-18 | 14 | TB2-9 | 14 | 29.50 |
| 183 | BLACK | P200N16 | A5-17 | 14 | TB1-7 | 14 | 28.00 |
| 184 | BLACK | P47E16 | A5-16 | 14 | TB3-8 | 14 | 32.00 |
| 185 | BLACK | P55U16 | A5-15 | 14 | TB2-1 | 14 | 32.50 |
| 186 | BLACK | P55VV16 | K3-X1 | 14 | TB2-2 | 14 | 30.00 |
| 187 | BLACK | P140H16 | K3-A2 | 23 | TB3-10 | 14 | 79.00 |
| 188 | BLACK | X194D16 | T1-2 | 14 | R29-1 | — | 53.00 |
| 189 | BLACK | X96A16 | T1-1 | 14 | TB3-4 | 14 | 46.50 |
| 190 | BLACK | P141F12 | R13-1 | 16 | TB2-13 | 24 | 21.00 |
| 191 | BLACK | P140F12 | R13-4 | 16 | TB3-10 | 24 | 23.00 |
| 192 | BLACK | X197D16 | TB3-7 | 14 | R1-1 | — | 46.00 |
| 193 | BLACK | P40AA16 | A5-1 | 14 | TB4-9 | 14 | 50.00 |

Figure 6-26. Mode 1 relay box wiring harness (Sheet 4 of 4)

## Section VII. RECONNECTION BOARD ASSEMBLY, CIRCUIT BREAKER ASSEMBLY, LOAD BOARD ASSEMBLY, AND TRANSFORMER ASSEMBLY

### 6-96. GENERAL.

The reconnection board, circuit breaker, load bus bars, load terminal board, and the current transformers are located on the rear right side of the generator.

a. The voltage reconnection system permits reconnection of the generator phase windings to give all specified output voltages. One end of each coil of each phase winding runs from the generator through an instrumentation and a static exciter current transformer to the reconnection panel. This assures current sensing in each phase regardless of voltage connection at the reconnection board assembly. The reconnection board assembly is equipped with a voltage change board to facilitate conversion to 120/208 or 240/416 generator output voltage. Positioning of the voltage change board connects two coils of each phase in series or parallel. In parallel, the output is 120/208; in series, the output is 240/416 VAC. The terminals on the reconnection board assembly for connection to the generator loads are numbered according to the particular coil end of each phase of the generator to ensure proper connections.

b. The reconnection terminal board assembly TB6 is connected to circuit breaker CB2. Circuit breaker CB2 has three main contacts within it which serve to connect or disconnect the load from the generator. The circuit breaker CB2 is connected to the load terminal board. The load terminal board has eight terminals; two terminals are marked L1, L2, L3, and L0, respectively.

c. The circuit breaker CB2 contains an auxiliary switch for operation of the "CIRCUIT BREAKER ON" light DS-6, Remote standby or Auto standby, and for parallel operation. Also, an undervoltage trip is provided to trip the circuit breaker when there is a loss or a major dip in the signal input.

### 6-97. RECONNECTION BOARD ASSEMBLY.

6-98. REMOVAL. Refer to paragraph 2-7 and remove the reconnection board assembly.

6-99. DISASSEMBLY. Refer to figure 6-27 and disassemble reconnection board assembly in the order of index numbers assigned. Pay particular attention to the following:

a. Each stud is numbered; note numbering sequence prior to removal to insure proper reassembly.

6-100. CLEANING. Clean parts in an approved cleaning solvent and dry thoroughly.

### 6-101. INSPECTION.

a. Inspect threads for damage.

b. Inspect terminal board and bus bars for cracks, warping, and burnt spots.

6-102. REASSEMBLY. Refer to figure 6-27 and reassemble reconnection board assembly in the reverse order of index numbers assigned. Pay particular attention to the following.

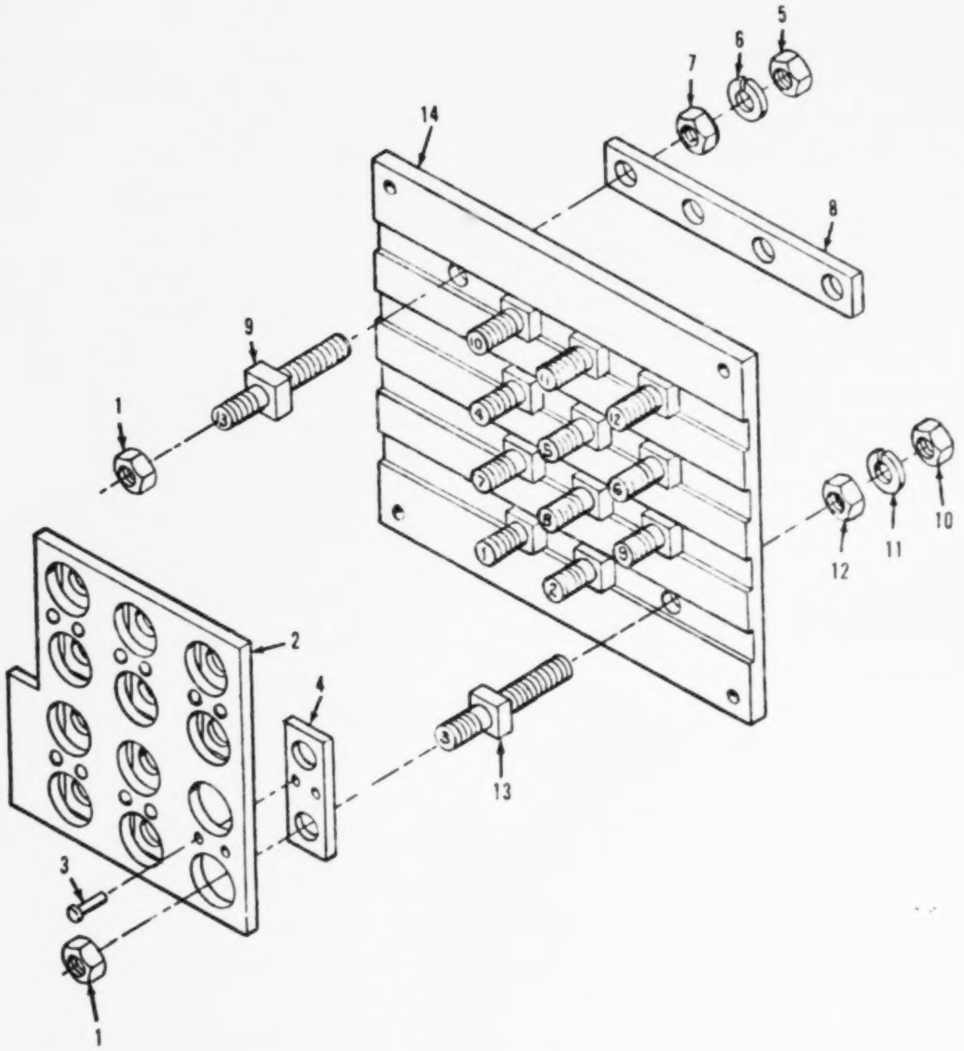

Figure 6-27. Reconnection board assembly, exploded view

Legend to figure 6-27:

1. Nut (13)
2. Voltage change board
3. Rivet (12)
4. Bus bar (6)
5. Nut (4)
6. Terminal board assembly washer (4)
7. Nut (4)
8. Bus bar
9. Stud (4)
10. Stud nut (9)
11. Stud washer (9)
12. Stud nut (9)
13. Stud (9)
14. Terminal board

a. Make sure studs are installed in proper numbering sequence.

6-103. INSTALLATION. Refer to paragraph 2-7 and install the reconnection board assembly.

## 6-104. CIRCUIT BREAKER ASSEMBLY.

### 6-105. TEST ON EQUIPMENT.

a. Symptom and Isolation of Malfunction. A malfunction of the circuit breaker is usually indicated by the circuit breaker opening when the generator is operating within normal parameters or the circuit breaker will not close to apply power to the load.

NOTE

Test should be accomplished with generator not operating and load cables disconnected.

1. Disconnect electrical connector from circuit breaker relay box connector J41. Connect a suitable voltmeter across pins M and B with B negative. Energize DC control circuit breaker. There should be approximately 24 volts.

2. Connect a suitable voltmeter across pins A and B of J41. Position start-run-stop switch to RUN, and position battle short switch to ON.

3. Position circuit breaker switch to CLOSE; voltmeter should indicate approximately 24 volts.

4. If voltage is not present in either step 2 or 3, check wiring back to its source and correct malfunctions.

5. If voltage is present but the contactor still will not close, check K26 Relay, OFF-ON Limit Switch, and Motor B1, and correct malfunction.

6. If the contactor closes and will not stay in the closed position, check undervoltage relay inside the circuit breaker.

7. Position load contactor switch to OPEN, battle short switch to OFF, and start-run-stop switch to STOP. De-energize circuit breaker.

8. Connect connector to circuit breaker relay box.

b. Removal. Refer to figure 6-28 and remove circuit breaker assembly as follows:

NOTE

Tag electrical leads with location to insure proper installation.

1. Press motor control cover release and lift motor control cover. Disconnect electrical harness from terminal strip and loosen electrical harness clamp. Remove electrical harness from motor control unit and close cover.

2. Remove motor control unit (4) from circuit breaker assembly (22) by removing screws (1), washers (2), and clamp (3).

3. Remove upper shield (5) and bottom shield (8) from circuit breaker assembly (22) by removing screws (5 and 6).

4. Remove bus bar assemblies (11) from circuit breaker assembly (22) by removing screws (9) and washers (10).

5. Remove six electrical leads from top of circuit breaker assembly (22) by removing nuts (12) and lock washers (13).

6. Disconnect electrical connector J41 from relay box (23) on circuit breaker assembly (22).

7. Remove circuit breaker assembly (22) by removing screws (14), nuts (15 and 16) and washers (17) that secure circuit breaker assembly to upper frame.

8. Remove load board assembly in accordance with paragraph 2-7, steps 6.a through 6.c in order to gain access to nuts

(19) that secure base of circuit breaker assembly (22) to frame.

9. Remove screws (18), nuts (19) and washers (20 and 21). Remove circuit breaker assembly (22) from frame (24).

10. Remove brace (28), shield (29) and clamp (30) from circuit breaker assembly (22) by removing screws (25), nuts (26) and washers (27).

6-106. TEST.

a. Connect circuit breaker assembly to test equipment as illustrated in figure 6-29 and perform test specified in procedural analysis table 6-11.

b. Remove test equipment.

6-107. DISASSEMBLY. Refer to figure 6-30, and disassemble circuit breaker assembly as follows:

a. Remove cover (2) from relay box (21) by removing screws (1).

b. Remove relay (5) from socket (9) by removing screws (3) and lock washers (4).

NOTE

Do not disconnect electrical leads from socket (9) unless replacement is required.

c. Tag and disconnect leads from terminal strip (19), and remove socket (9) with attaching leads from relay box (21) by removing nuts (6), washers (7), and lock washers (8).

NOTE

Do not disconnect electrical leads from connector J41 (12) unless replacement is required.

d. Tag and disconnect leads from terminal strip (19), and remove connector J41 (12) with attaching leads from relay box (21) by removing nuts (10) and screws (11).

e. Disconnect electrical harness (13) from terminal strip (19). Remove electrical harness (13) from mount (38) by removing nuts (14), lock washers (15), and clamps (16).

f. Disconnect circuit breaker leads from terminal strip (19).

g. Remove terminal strip (19) from mount (38) by removing nuts (17) and screws (18).

h. Remove relay box (21) from mount (38) by removing screws (20).

i. Remove circuit breaker (37) from mount (38) by removing nuts (14) and lock washers (15).

j. Remove cover and top shield assembly (24) by removing screws (22) and lock washers (23).

NOTE

Top shield may be removed from cover if required by removing two screws.

WARNING

Keep hands clear of mechanism at all times.

k. Remove under voltage trip assembly (27) by removing screw (25) and lock washer (26).

l. Remove auxiliary switch assembly (30) by placing handle of circuit breaker (37) in the ON position and remove screw (28) and lock washer (29).

m. Remove shields (31) from circuit breaker (37).

n. Position handle of circuit breaker (37) to ON and remove screws (32), lock washers (33), and washers (34) securing dummy trip assembly (35) on circuit breaker. Trip circuit breaker by pushing one of the buttons (6 or 7 on the dummy trip assembly

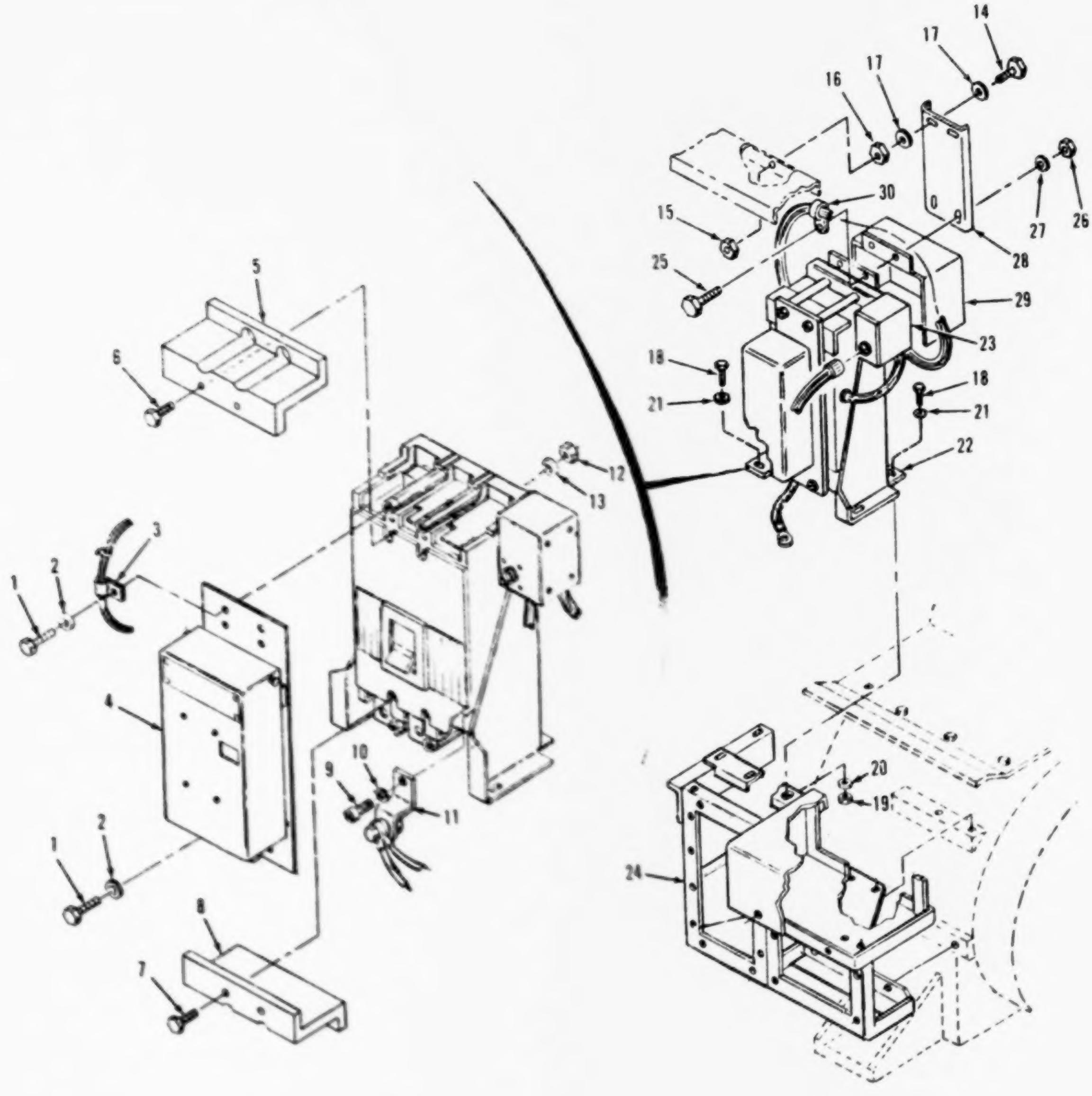
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Figure 6-28. Circuit breaker assembly (CB2). removal and installation

Legend to figure 6-28:

1. Screw (4)
2. Screw (4)
3. Clamp
4. Motor control unit
5. Shield
6. Screw
7. Screw (2)
8. Shield
9. Screw (3)
10. Washer (3)
11. Bus bar assembly (3)
12. Nut (3)
13. Lock washer (3)
14. Screw (2)
15. Nut (2)
16. Nut (2)
17. Washer (4)
18. Screw (4)
19. Nut (4)
20. Lock washer (4)
21. Washer (4)
22. Circuit breaker assembly
23. Relay box
24. Frame
25. Screw (2)
26. Nut (2)
27. Washer (2)
28. Brace
29. Shield
30. Clamp

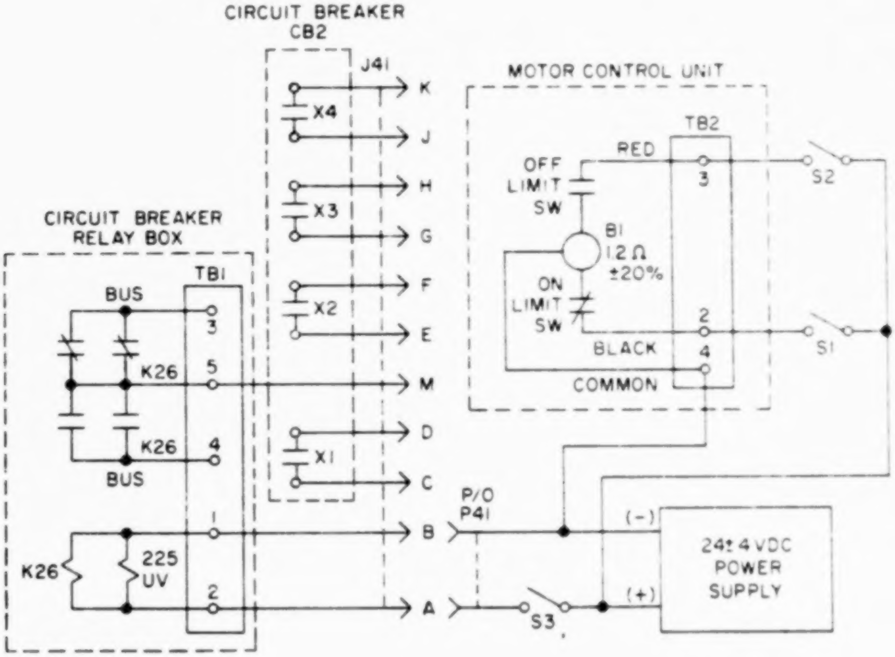

CIRCUIT BREAKER
CB2
J41
K
X4
J
H
X3
G
F
X2
E
M
D
X1
C
B
A
MOTOR CONTROL UNIT
TB2
RED
OFF
LIMIT
SW
3
S2
B1
1.2 Ω
±20%
ON
LIMIT
SW
2
S1
BLACK
4
COMMON
CIRCUIT BREAKER
RELAY BOX
TB1
BUS
3
K26
5
K26
4
BUS
1
K26
225
UV
2
P/O
P41
(-)
(+)
24±4 VDC
POWER
SUPPLY
S3

Figure 6-29. Circuit breaker assembly (CB2), test setup

figure 6-31). Hold trip lever (1) down, disengage hook (2) from slot (3) and lift out dummy trip assembly (35, figure 6-30).

o. Remove stud (36) from circuit breaker (37).

6-108. CLEANING.

a. Clean all components with a clean lint-free cloth moistened with an approved cleaning solvent and dry thoroughly.

6-109. INSPECTION.

a. Inspect wiring for evidence of damaged insulation and continuity.

b. Inspect terminal block for cracked insulation and stripped threads.

c. Inspect relay socket for cracked insulation and broken pin receptacles.

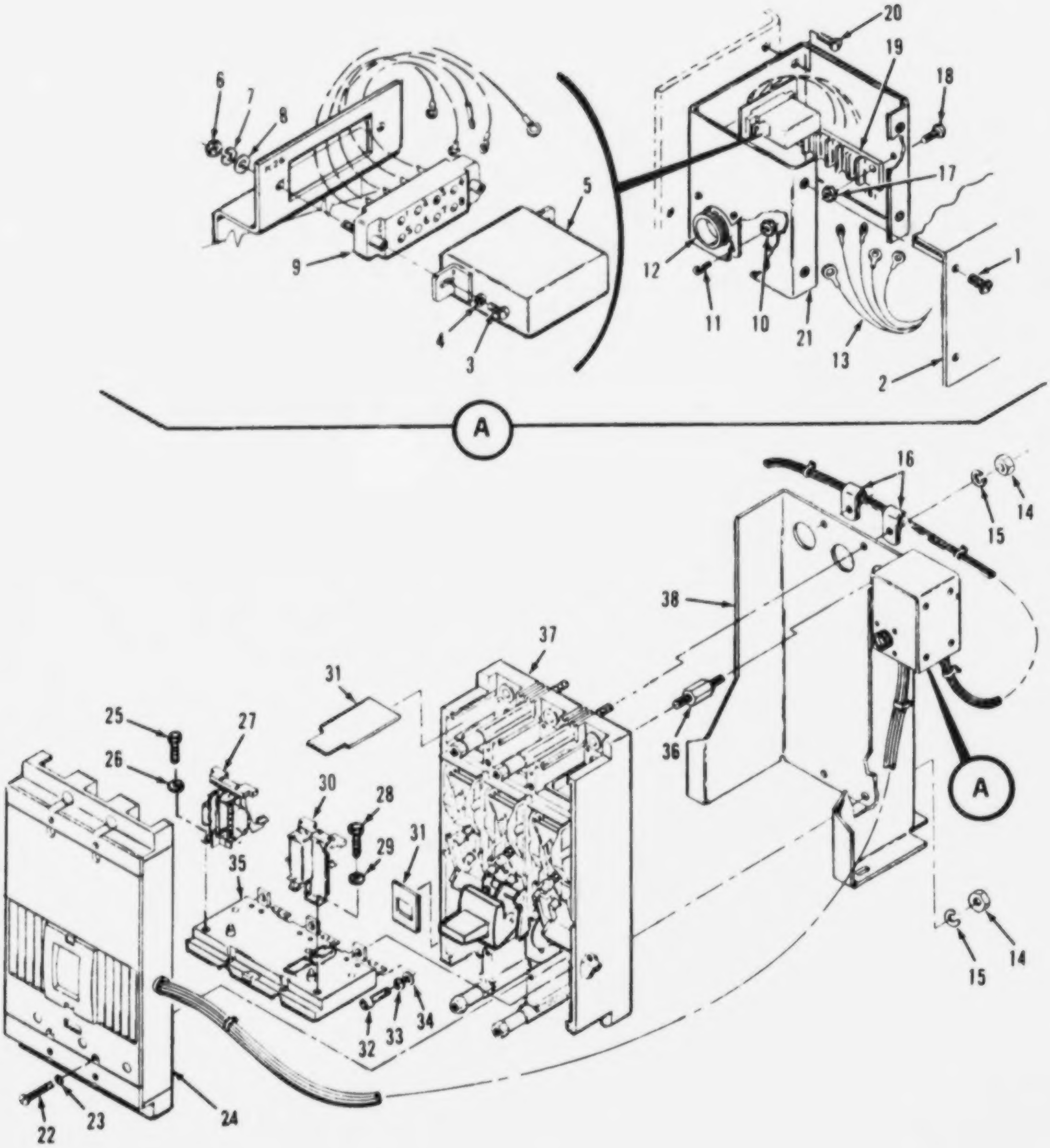
d. Test plug in relay for actuation as illustrated in figure 6-5.

Table 6-11. Circuit Breaker Assembly (CB2), Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| | | NOTE<br>Motor control unit is removed from circuit breaker assembly during the following tests. | | |
| 1 | With all switches open, and motor control indicator in the green "OFF" position, close switch S1. | Motor B1 should energize, and indicator should position to red "ON". | Motor B1 open. | Check continuity of motor. |
| | | | Limit switch open. | Check continuity of switch. |
| 2 | Open switch S1 and close switch S2. | Motor B1 should energize and indicator should position to green "OFF". | Motor B1 open. | Check continuity of motor. |
| | | | Limit switch open. | Check continuity. |
| 3 | With all switches open. close switch S3 and manually close the circuit to the "ON" position. | Circuit breaker should stay closed. | Under voltage trip relay open. | Check continuity. |
| | | There should be continuity between J41 pins:<br>C to D<br>E to F<br>G to H<br>J to K | Open auxiliary switch. | Replace switch. |

Table 6-11. Circuit Breaker Assembly (CB2). Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 3 (cont) | | There should be continuity between TB1-4 and -5, and no continuity between TB1-3 and -5. | Defective K-26 relay. | Check relay continuity. |
| 4 | Open switch S3. | Circuit breaker should move to trip position. | Defective under voltage trip relay. | Check relay continuity. |
| | | There should be no continuity between J41 pins:<br>C to D<br>E to F<br>G to H<br>J to K | Defective auxiliary switch. | Replace switch. |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31
36
A
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22
23
24
32
33
34

Figure 6-30. Circuit breaker assembly, exploded view

Legend to figure 6-30:

1. Screw (4)
2. Cover
3. Screw (2)
4. Lock washer (2)
5. Relay
6. Nut (2)
7. Washer (2)
8. Lock washer (2)
9. Socket
10. Nut (4)
11. Screw (4)
12. Connector (J41)
13. Electrical harness
14. Nut (4)
15. Lock washer (4)
16. Clamp (2)
17. Nut (2)
18. Screw (2)
19. Terminal strip
20. Screw (2)
21. Relay box
22. Screw (4)
23. Lock washer (4)
24. Cover and top shield
25. Screw
26. Lock washer
27. Under voltage trip assembly
28. Screw
29. Lock washer
30. Auxiliary switch assembly
31. Shield (7)
32. Screw (3)
33. Lock washer (3)
34. Washer (3)
35. Dummy trip assembly
36. Stud (3)
37. Circuit breaker
38. Mount

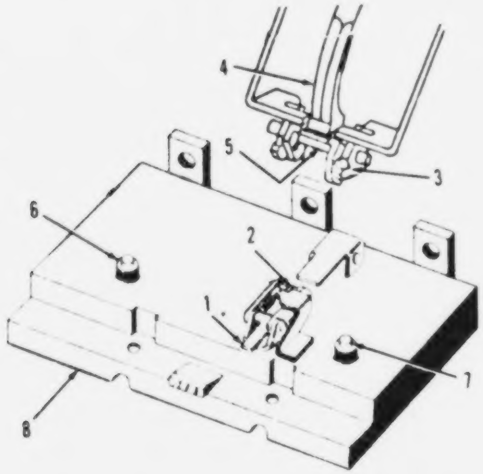


Figure 6-31. Dummy trip assembly, removal and installation

Legend to figure 6-31:

1. Trip lever
2. Hook
3. Slot
4. Trigger
5. Latch
6. Button
7. Button
8. Dummy trip assembly

e. Inspect electrical connector for cracked housing, broken or loose pins, and stripped threads.

f. Inspect circuit breaker contact points for signs of pitting, corrosion, and arcing.

6-110. REPAIR.

a. Repair cracked sheet metal parts by welding. Straighten distorted parts using suitable tools.

b. Chase damaged threads in mount.

c. Remove damaged paint. Blend in edge, prime, and paint damaged areas.

d. Repair or fabricate relay box wiring in accordance with table 6-12.

6-111. REASSEMBLY. Refer to figure 6-30, and reassemble circuit breaker assembly as follows:

a. Install studs (36) on circuit breaker (37).

Table 6-12. Circuit Breaker Assembly Wiring Data

| WIRE | | | | | | |
|---|---|---|---|---|---|---|
| COLOR | NUMBER | FROM | TERMINATION NOTE | TO | TERMINATION NOTE | LENGTH |
| WHITE | P400A16 | TB2-2 | 2 | TB1-4B | 2 | 34.00 |
| WHITE | P400B16 | TB1-4A | 2 | K26-4 | 1,4,5 | 5.00 |
| WHITE | P400C16 | TB1-4A | 2 | K26-5 | 1,4,5 | 5.00 |
| WHITE | P401A16 | TB2-3 | 2 | TB1-3B | 2 | 34.00 |
| WHITE | P401B16 | TB1-3A | 2 | K26-1 | 1,4,5 | 5.00 |
| WHITE | P401C16 | TB1-3A | 2 | K26-8 | 1,4,5 | 5.00 |
| WHITE | P402A16 | TB2-4 | 2 | TB1-1B | 2 | 34.00 |
| WHITE | P402B16 | TB1-1A | 2 | K26-7 | 1,4,5 | 5.00 |
| WHITE | P402C16 | TB1-1A | 2 | J41-B | 1,4,5 | 5.00 |
| BLUE | - | UV-CB2 | 1,4,5 | TB1-1B | 2 | 38.00 |
| BLUE | - | UV-CB2 | 1,4,5 | TB1-2B | 2 | 38.00 |
| WHITE | P403A16 | TB1-2A | 2 | K26-2 | 1,4,5 | 5.00 |
| WHITE | P403B16 | TB1-2A | 2 | J41-A | 1,4,5 | 5.00 |
| WHITE | P404A16 | TB1-5A | 2 | K26-3 | 1,4,5 | 5.00 |
| WHITE | P404B16 | TB1-5A | 2 | J41-M | 1,4,5 | 5.00 |
| WHITE | P404C16 | TB1-5B | 2 | K26-6 | 1,4,5 | 5.00 |
| WHITE | - | J41-K | 1,4,5 | CB2-X4 | 1,4,5 | 11.00 |
| RED | - | J41-J | 1,4,5 | CB2-X4 | 1,4,5 | 11.00 |
| WHITE | - | J41-H | 1,4,5 | CB2-X3 | 1,4,5 | 11.00 |
| RED | - | J41-G | 1,4,5 | CB2-X3 | 1,4,5 | 11.00 |
| WHITE | - | J41-F | 1,4,5 | CB2-X2 | 1,4,5 | 11.00 |
| RED | - | J41-E | 1,4,5 | CB2-X2 | 1,4,5 | 11.00 |
| WHITE | - | J41-D | 1,4,5 | CB2-X1 | 1,4,5 | 11.00 |
| RED | - | J41-C | 1,4,5 | CB2-X1 | 1,4,5 | 11.00 |

NOTES

1. Solder, use Federal Specification QQ-S-571, SN 60
2. Secure end with terminal lug, MS25036-106.
3. Wire is M5086/2-16-9 per MIL-W-5086/2.
4. Use 5/8 inch long isulation tubing over each contact after soldering.
5. Insulation is TYPE F, FORM Ua, GRADE A, CLASS 1, CATEGORY 1.

WARNING

Keep hands clear of mechanism at all times.

b. Install screws (32), lock washers (33), and washers (34) into dummy trip assembly (35). Push in and hold trip lever (1, figure 6-31) and place dummy trip assembly into position. Engage hook (2) with slot (3). Tighten center screw (32, figure 6-30), then remaining two outside screws. Recheck that hook is engaged in slot.

c. Push handle of circuit breaker (37) to extreme OFF, engage trigger (4, figure 6-31) with latch (5). Push handle of circuit breaker to the ON position. Trip circuit breaker by pushing button (6). Reset breaker and trip again using button (7).

d. Install shields (31, figure 6-30) on circuit breaker (37).

e. Position handle of circuit breaker to ON, place phenolic support of auxiliary switch assembly (30) into groove of circuit breaker molded base. Secure the auxiliary switch assembly to dummy trip assembly (35) with screw (25) and lock washer (26).

NOTE

Insure that when circuit breaker is in the OPEN position, auxiliary switch actuator does not depress auxiliary buttons. Auxiliary switch buttons are depressed only when the circuit breaker is in the ON position.

f. Install under voltage trip assembly (27) on circuit breaker (37) and secure with screw (28) and lock washer (29). Hold under voltage trip assembly (27) core in solenoid, and position circuit breaker ON. Slowly release solenoid core, and trip circuit breaker.

g. Install cover (24) on circuit breaker (37) and secure with screws (22) and lock washers (23).

h. Install circuit breaker (37) on mount (38) and secure with nuts (14) and lock washers (15).

i. Install relay box (21) on mount (38) and secure with screws (20).

j. Install terminal strip (19) in relay box (21) and secure with screws (18) and nuts (17).

k. Install electrical harness (13) with clamps (16) on mount (38) and secure with lock washers (15) and nuts (14).

l. Install connector (12) on relay box (21) and secure with screws (11) and nuts (10).

m. Install socket (9) on relay box (21) and secure with lock washers (8), washers (7), and nuts (6).

n. Connect circuit breaker (37), connector (12), socket (9), and electrical harness (13) leads on terminal strip (19).

o. Install relay (5) and secure with screw (3) and lock washer (4).

p. Install cover (2) on relay box (21) and secure with screws (1).

6-112. INSTALLATION. Refer to figure 6-28, and install circuit breaker assembly as follows:

a. Install circuit breaker assembly (22) on frame (24) and secure with screws (18), nuts (19) and washers (20 and 21).

b. Install load board assembly in accordance with paragraph 2-7, steps 6.a through 6.c.

c. Install brace (28), shield (29) and clamp (30) on circuit breaker assembly (22) and secure with screws (25), nuts (26) and washers (27).

d. Secure circuit breaker assembly (22) to upper frame with screws (14), nuts (15) and (16) and washers (17).

e. Install six electrical leads on top of circuit breaker assembly (22) and secure with nuts (12) and lock washers (13).

f. Install bus bar assembly (11) on circuit breaker assembly (22), and secure with screws (9) and washers (10).

g. Install upper and bottom shield (5 and 8) on circuit breaker assembly (22) and secure with screws (6 and 7).

h. Install motor control unit (4) on circuit breaker assembly (22) with cover open and circuit breaker handle in the OFF position. Adjust the motor control unit, sliding carriage, until it engages the circuit breaker handle. Adjustment is accomplished by turning slot at end of screwed shaft with a screw driver. Secure with screws (1), washers (2), and clamp (3).

i. Install electrical harness (B) on motor control unit (4). Connect leads on terminal strip and tighten clamp.

j. Connect electrical connector J41 to relay box on circuit breaker assembly (22).

## 6-113. LOAD BOARD ASSEMBLY.

6-114. REMOVAL. Refer to paragraph 2-7 and remove the load board assembly.

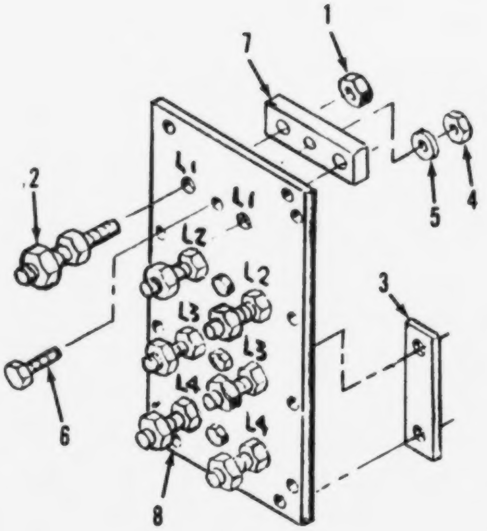


Figure 6-32. Load connection board assembly, exploded view

6-115. DISASSEMBLY. Refer to figure 6-32 and disassemble load board assembly in order of index numbers assigned.

6-116. CLEANING. Clean parts in an approved cleaning solvent and dry thoroughly.

## 6-117. INSPECTION.

a. Inspect threads for damage.

b. Inspect terminal board for cracks, warping, and burnt areas.

6-118. REASSEMBLY. Refer to figure 6-32, and reassemble load board assembly in the reverse order of index numbers assigned.

6-119. INSTALLATION. Refer to paragraph 2-7 and install load board assembly.

## 6-120. CURRENT TRANSFORMER AND FRAME ASSEMBLY.

6-121. REMOVAL. Remove current transformer and frame assembly as follows:

a. Refer to paragraph 2-7, and remove current transformer and frame assembly.

6-122. DISASSEMBLY. Refer to figure 6-33, and disassemble current transformer and frame assembly in the order of index numbers assigned.

### 6-123. CLEANING.

a. Clean transformers with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

b. Clean remaining parts in an approved cleaning solvent and dry thoroughly.

### 6-124. INSPECTION.

a. Inspect transformer leads for defective insulation. Inspect terminal lugs for condition and security.

b. Inspect terminal block for cracked insulation, stripped threads, and missing jumper strips.

c. Inspect sheet metal parts for distortion and cracks.

d. Inspect threads for damage.

e. Test transformers for proper operation; refer to figure 6-34.

f. Inspect paint for damage.

### 6-125. REPAIR.

a. Repair cracked sheet metal parts by welding. Straighten distorted parts using suitable tools.

b. Chase damaged threads in bracket.

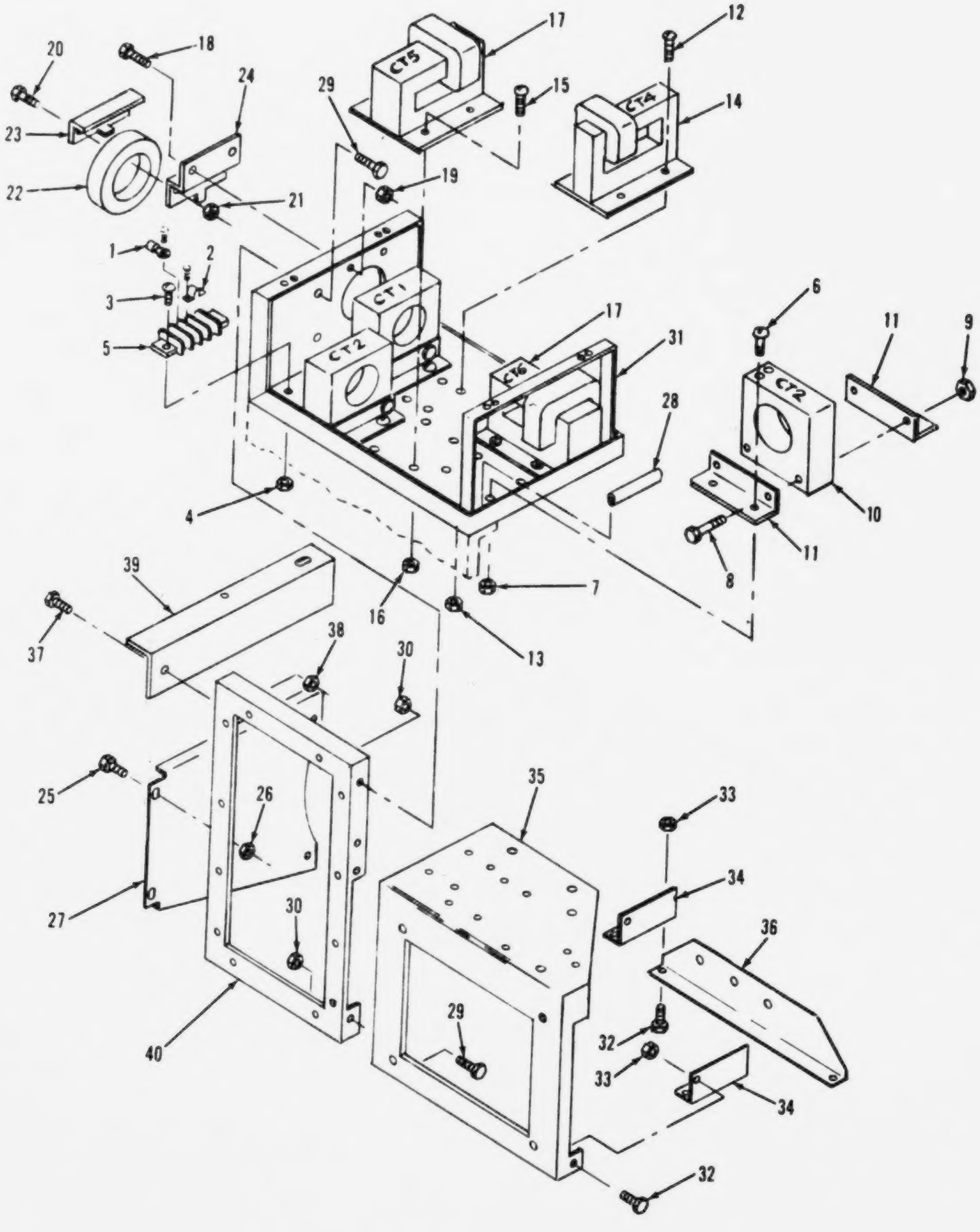
c. Remove damaged paint. Blend in edge, prime, and paint damaged areas.

### 6-126. REASSEMBLY.

Refer to figure 6-33 and reassemble current transformer and frame assembly in the reverse order of index numbers assigned.

6-127. INSTALLATION. Install current transformer and frame assembly as follows:

a. Refer to paragraph 2-7, and install current transformer and frame assembly.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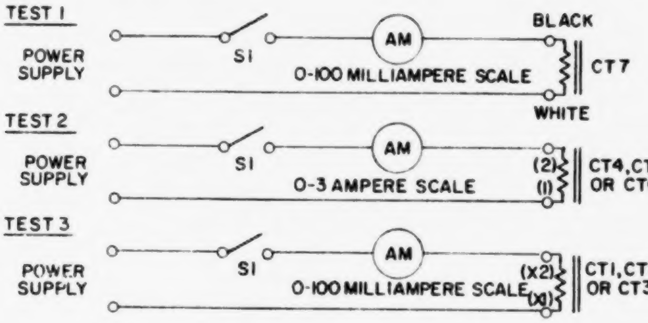
33
34
35
36
37
38
39
40
CT1
CT2
CT4
CT5
CT6

Figure 6-33. Current transformer and frame assembly, exploded view

Legend to figure 6-33:

1. Terminal lug (2)
2. Jumper (2)
3. Screw assembly (3)
4. Nut assembly (4)
5. Terminal block
6. Screw (6)
7. Nut (6)
8. Instrument transformer (T1, T2, T3)
9. Screw assembly (12)
10. Nut assembly (12)
11. Bracket (6)
12. Screw assembly (4)
13. Nut assembly (4)
14. Exciter (phase A) transformer (T4)
15. Screw assembly (8)
16. Screw assembly
17. Exciter transformer (T5, T6)
18. Screw assembly (2)
19. Nut assembly (2)
20. Screw (2)
21. Nut assembly (2)
22. Cross current transformer (T7)
23. Bracket
24. Mounting plate
25. Screw
26. Nut
27. Angle
28. Bracket
29. Screw (5)
30. Nut (5)
31. Strip
32. Panel
33. Screw (3)
34. Nut (3)
35. Angle
36. Panel
37. Screw (4)
38. Nut (4)
39. Angle
40. Angle
41. Angle
42. Screw
43. Nut
44. Angle
45. Spacer
46. Panel


TEST 1
POWER SUPPLY
S1
AM
0-100 MILLIAMPERE SCALE
BLACK
WHITE
CT7
TEST 2
POWER SUPPLY
S1
AM
0-3 AMPERE SCALE
(2)
(1)
CT4,CT5 OR CT6
TEST 3
POWER SUPPLY
S1
AM
0-100 MILLIAMPERE SCALE
(X2)
(X1)
CT1,CT2 OR CT3

| TRANSFORMER | INPUT | MAXIMUM | RESISTANCE | TEST SETUP |
|---|---|---|---|---|
| | | EXCITATION CURRENT | VALUE ± 20 PERCENT | |
| CROSSCURRENT TRANSFORMER CT7 | 10 VAC @ 60 HZ | 0.070 AMPERES | 2.543 OHMS | 1 |
| EXCITER CURRENT TRANSFORMERS CT5 AND CT6 | 60 VAC @ 60 HZ | 1.35 AMPERES | 0.176 OHMS | 2 |
| EXCITER CURRENT TRANSFORMER CT4 | 60 VAC @ 60 HZ | 0.36 AMPERES | 0.912 OHMS | 2 |
| INSTRUMENT CURRENT TRANSFORMER CT1 | 12.5 VAC @ 60 HZ | 0.088 AMPERES | 6.990 OHMS | 3 |
| INSTRUMENT CURRENT TRANSFORMERS CT2 AND CT3 | 12.5 VAC @ 60 HZ | 0.088 AMPERES | 7.260 OHMS | 3 |

Figure 6-34. Current transformer test

## Section VIII. TACTICAL RELAY BOX

### 6-128. GENERAL.

The tactical relay box (A7) contains the over voltage relay, reverse power relay, short circuit relay, overload relay, and the three current transformer load resistors. Refer to schematic diagram, figure 1-12.

a. The over voltage relay (K2) is a solid state device which functions to protect the load in the event that generator voltage exceeds preset limits. It actuates after a time delay from 180 to 800 milliseconds when generator voltage rises above 156 VAC. Upon actuation, contacts within the over voltage relay, close to signal the fault locator and open to shutdown the generator set.

1. The ac input voltage is rectified by diode CR1 and applied to a voltage divider network consisting of resistors R2, R3, and R5. Zener diode CR4 will conduct when the voltage at the wiper of R5 exceeds its zener breakdown voltage. The point at which the ac input voltage will cause the zener breakdown of CR2 can be adjusted by R5.

2. When an over voltage condition occurs, zener diode CR4 conducts and triggers SCR1 for conduction. This energizes relay K1 and causes its contacts to transfer. Resistor R1 limits the current to relay while the voltage to the relay is limited to a peak value of 30 ± 10 percent by zener diodes CR2 and CR3.

3. Resistor R4 and capacitor C3 prevent transients from triggering silicon controlled switch SCR1 into conduction.

b. The reverse power relay (K15) is a solid state device which functions to protect the generator in the event of a reverse power operating state during parallel operation. It operates in conjunction with the load measurement unit which produces a dc output voltage whose polarity and magnitude is a function of the kilowatt or real load on the generator set regardless of phase or power factor. When the reverse power flow into the generator exceeds twenty percent of rated load; the load measurement unit output has sufficient magnitude and correct polarity to cause the reverse power relay to activate. This reverse power rating pertains to the 60 hertz rating. Upon actuation, contacts within the reverse power relay; close to signal the fault locator and open to deenergize the load contactor, result in display of the fault condition and removal of the load from the generator.

1. During normal operation with power passing from the generator set to the load; the load measurement unit impresses a dc signal across terminals 1 and 2 of the reverse power relay, with terminal 1 (-) and terminal 2 (+). This reverse biases transistor Q1 off, causing the darlington pair Q2 and Q3 to be off and relay coil K1 to be deenergized. Thus, under all conditions of forward power by the generator set; relay K1 will be deenergized and terminals 5 and 6 remain open and terminals 7 and 8 are shorted.

2. The reverse power trip level control potentiometer R2 is factory adjusted to cause relay coil K1 to be energized when dc voltage of 2 ± 1 volts is impressed across terminals 1 and 2, with terminal 1 (+) and terminal 2 (-). This adjusted trip voltage represents approximately two percent reverse power.

3. When the system reverse power reaches twenty percent; the dc voltage across the wiper of R2 and terminal 2 has sufficient magnitude to turn Q1 on. The superimposed ac voltage on the dc input to terminals 1 and 2 is then impressed across the anode of CR2 and terminal 4. Diode CR3 rectifies this ac signal and capacitor C2 smooths it. The resultant dc voltage forward biases the darlington pair Q2 and Q3 on; causing relay coil K1 to be energized.

c. The short circuit relay (K13) is a solid state device which functions to protect the load in the event generator output current in any phase exceeds 425 ± 25 percent of rated current. This current rating pertains to the 60 hertz rating. When the above fault occurs, the short circuit relay will actuate. Upon actuation, contacts within the short circuit relay; close to signal the fault locator and open to deenergize the load contactor, resulting in display of the fault condition and removal of the load from the generator.

1. The sensing input terminals 1, 2, and 3 are connected to a current transformer

for each phase of generator output. Diodes CR1 through CR3 rectify the input current to terminals 1, 2, and 3.

2. In the event of a short circuit condition, one or more of the sensing transformer secondary currents increase. This causes the rectified DC voltage level across the voltage divider network, consisting of resistors R1 and R6, to increase.

3. Potentiometer R6 is adjusted so that transistor Q2 is forward biased when the input voltage on any phase to neutral is 24 ± 1.5 VAC at 60 hertz. When Q2 conducts, transistor Q1 is forward biased causing it to switch on, applying voltage to the relay coil. A signal is fed back to the top of R6 through resistor R4, causing the relay to latch in the tripped state. When the AC input voltage to neutral falls below 18 VAC, the relay unlatches.

d. The overload relay (K14) is a solid state device whose function is to protect the load in the event of an overload condition. An overload condition is defined as the state when generator output current in any phase exceeds 110 percent of rated value. The overload relay is a current sensing device and operates on an inverse time principle as the current in any phase exceeds the overload state. At the point just above 130 percent of rated current, the overload relay will actuate within 8 ± 2 minutes. This current rating pertains to the 60 hertz rating. Upon actuation, contacts within the overload relay close to signal the fault locator and open to deenergize the load contactor, resulting in display of the fault condition and removal of the load from the generator.

## 6-129. OVER VOLTAGE RELAY (K2).

## 6-130. ON EQUIPMENT TEST.

a. Symptom and Isolation of Malfunction. A malfunction of the overvoltage relay K2 is usually indicated by failure of the generator fault monitoring system to detect and react to a voltage rise beyond preset limits. To isolate the malfunction, proceed as follows.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

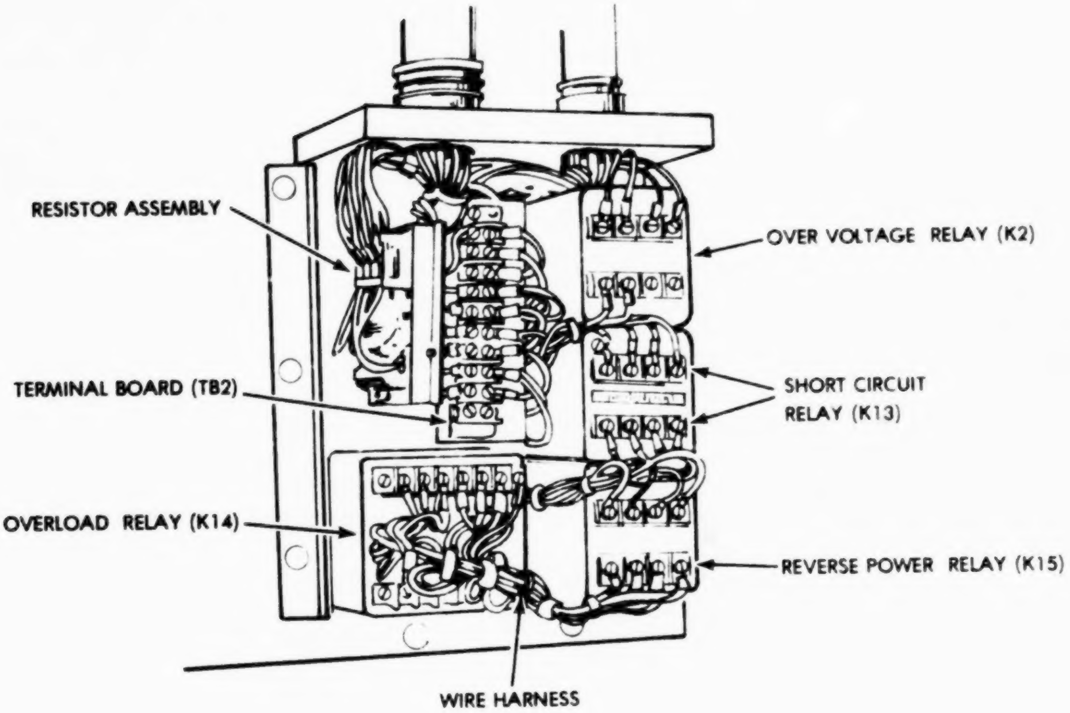
NOTE

Remove cover from tactical relay box to gain access to test points, see figures 6-14 and 6-35.

1. With the generator set operating at the rated speed and voltage, and with the contactor closed, measure the voltage from terminal 1 to terminal 2 of the K2 relay. Nominal voltage is 120 VAC. Voltage from TB2-5 to K2 terminals 3 and 6 should measure 20-32 VDC. Shutdown generator set.

2. Install a 250 ohm, 25 watt resistor in series with voltage adjustment rheostat R2 between wire number X9F10 and TB1-7 located in the control cubicle. With the generator set operating at the rated speed and voltage, increase output voltage such that the voltage across terminals 1 and 2 of K2 relay measures 153 ± 3 volts. When the K2 relay actuates there should be a momentary dc voltage measured from terminal 7 of K2 to TB2-5 and there should be no dc voltage measured from terminal 3 of K2 to TB2-5. If the above conditions are not met, replace the K2 relay.

b. Removal. Refer to figure 6-35 and tag, then disconnect wiring at the overvoltage relay terminals. Remove the four screw assemblies securing the relay in position.


RESISTOR ASSEMBLY
TERMINAL BOARD (TB2)
OVERLOAD RELAY (K14)
WIRE HARNESS
OVER VOLTAGE RELAY (K2)
SHORT CIRCUIT RELAY (K13)
REVERSE POWER RELAY (K15)

NOTES:

1. REMOVE THE FOUR SCREWS AND WASHERS SECURING THE COVER TO THE CHASSIS TO GAIN ACCESS TO THE TEST POINTS.
2. TACTICAL RELAY BOX MUST BE REMOVED FROM GENERATOR SET TO ACCOMMODATE REPLACEMENT OF RELAYS. TO REMOVE THE BOX ASSEMBLY, TAG AND DISCONNECT THE TWO ELECTRICAL PLUG CONNECTORS AT J4 AND J51, THEN REMOVE TWO SCREWS AND WASHERS SECURING THE BOX IN POSITION.
3. REPLACE ASSEMBLY BY REVERSING ABOVE PROCEDURES.

Figure 6-35. Tactical relay box (A29), cover removed

6-131. OFF EQUIPMENT TEST.

(a) Connect a variable (0 to 100 volts) ac voltage source and variable frequency (50 to 450 Hz) source to terminals 1 and 2 (See fig. 8-9).

(b) Connect a lamp and 24 Vdc power supply in series with terminals 3 and 4 (DS1), also with terminals 7 and 8 (DS2).

(c) Set voltage to 120 volts on terminals 1 and 2 and vary the frequency from 50 to 450 Hz. DS1 should stay lit and DS2 shall remain extinguished.

(d) Slowly increase the voltage to 149 volts. Vary the frequency from 350 to 450 Hz. DS1 should stay lit and DS2 shall remain extinguished.

(e) Slowly increase the voltage to 154 volts. Vary the frequency from 50 to 100 Hz. DS1 should stay lit and DS2 shall remain extinguished.

(f) Set the frequency at 50 Hz and increase the voltage to 156 volts. DS1 shall extinguish and DS2 shall light. Repeat for the frequency at 60, 70 and 100 Hz. After each trip, remove ac power to clear the relay.

(g) Set the frequency at 350 Hz and increase the voltage to 151 volts. DS1 shall extinguish and DS2 shall light. Repeat for the frequency 400 to 450 Hz. After each trip, remove ac power to clear the relay.

(h) Terminals 3, 4, 5, and 6, 7, 8 and terminals 1 and 2 shall be electrically isolated.

6-132. INSTALLATION. Refer to figure 6-35 and assemble the over voltage relay in position using four screw assemblies. Refer to figure 1-13 and reconnect wiring. Replace the tactical relay box and cover.

6-133 thru 6-137 Deleted.

6-138. REVERSE POWER RELAY (K15).

6-139. ON EQUIPMENT TEST.

a. Symptom and Isolation of Malfunction. A malfunction of the reverse power relay K15 is usually indicated by failure of the generator fault monitoring system to detect and react to a reverse power condition when operating two or more generator sets in parallel. To isolate the malfunction, proceed as follows.

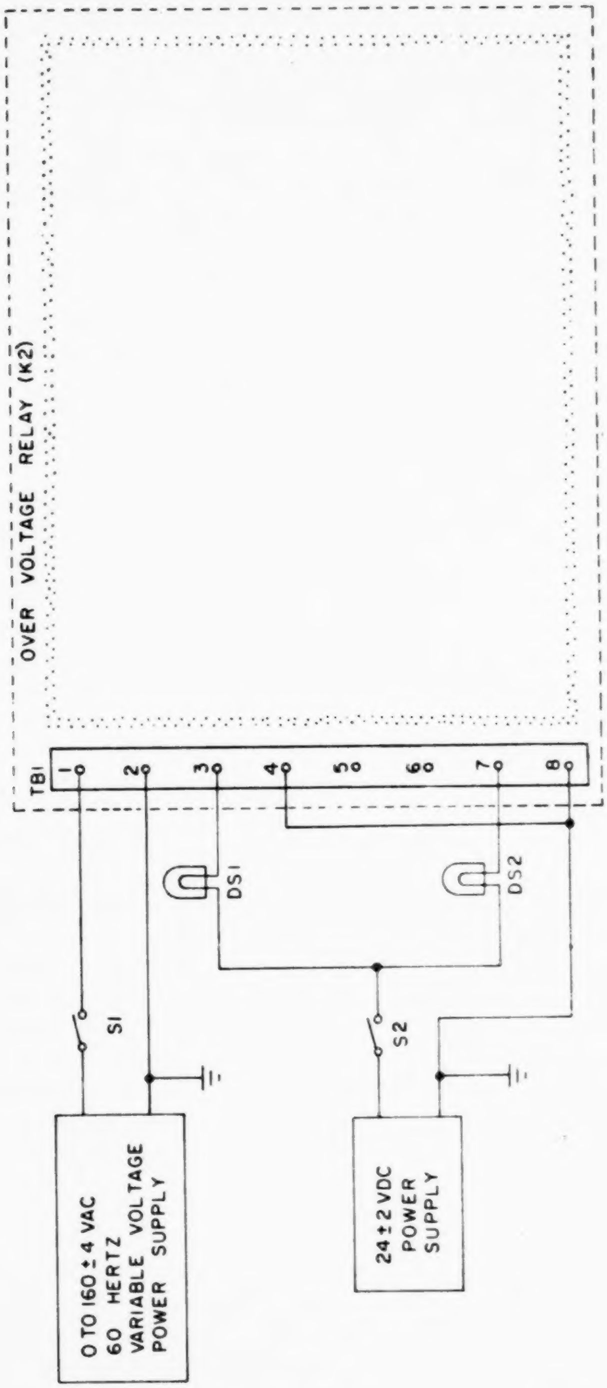

OVER VOLTAGE RELAY (K2)
TB1
1
2
3
4
5
6
7
8
DS1
DS2
S1
S2
0 TO 160 ± 4 VAC
60 HERTZ
VARIABLE VOLTAGE
POWER SUPPLY
24 ± 2 VDC
POWER
SUPPLY

Figure 6-36. Over voltage relay (K2), test setup

All data on pages 100 thru 103, including Figures 6-37 and 6-38, deleted.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical realy box with generator set operating.

NOTE

Remove cover from tactical relay box to gain access to test points. See figures 6-35 and 6-39 and refer to paragraph 6-79.

1. Operate the generator set in parallel with another like unit.

NOTE

To perform test with a single unit reverse leads to terminals 1 and 2 and apply load.

2. Adjust voltage and frequency to rated value and measure the voltage across terminals 3 and 4 of relay K15. In addition, measure the voltage from TB2-5 to K15 relay terminals 5 and 8. Voltage should be 20-32 VDC at all points.

3. Slowly reduce the generator set (unit under test) speed while monitoring the voltage across terminals 1 and 2 of relay K15 (approximately 9.8 VDC, terminal 2 positive, at 100 percent load). When the voltage is zero, reverse the meter leads and continue lowering the speed. Relay K15 should actuate when the voltage is 2 ± 0.1 VDC and terminal 1 is positive. If the relay does not actuate under the preceding conditions, replace the relay.

b. Removal. Refer to figure 1-13 and 6-35 and tag, then disconnect wiring from the reverse power relay. Remove the four screw assemblies securing the relay in position.

6-140. OFF EQUIPMENT TEST

(a) Connect relay as illustrated in figure 6-39.

(b) With all switches open, energize 5 VDC variable power supply and adjust until V1 reads 3 volts.

(c) Position switch S2 to B. Energize 24 VDC supply and close switches S4, S1 and S5. Lamp DS2 should light and DS1 should be extinguished.

(d) Energize 0 to 10 Vac power supply and adjust voltage until V2 indicates 5 volts. Adjust 0 to 5 VDC supply to a value less than 1 VDC shown on V1. Position switch S2 to A and close switch S3. Raise voltage of 0 to 5 VDC power supply until DS2 extinguishes and DS1 lights. DS1 should light when V1 indicates 1 to 3 volts.

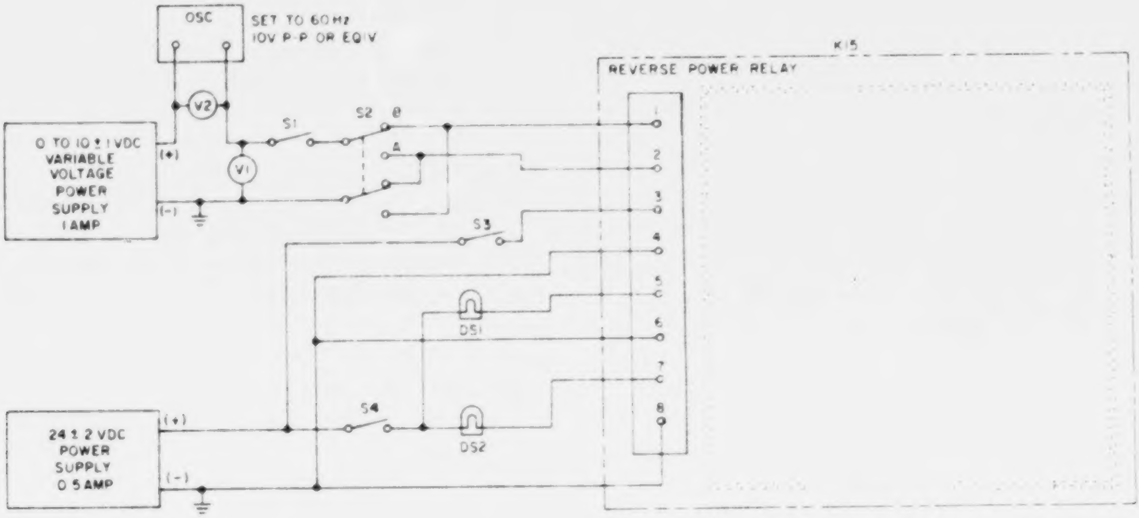

OSC
SET TO 60 Hz
10V P-P OR EQIV
0 TO 10 ± 1 VDC VARIABLE VOLTAGE POWER SUPPLY 1 AMP
(+)
(-)
V2
V1
S1
S2
B
A
S3
S4
DS1
DS2
24 ± 2 VDC POWER SUPPLY 0.5 AMP
(+)
(-)
K15
REVERSE POWER RELAY
1
2
3
4
5
6
7
8

Figure 6-39. Reverse power relay (K15), setup

6-141. INSTALLATION. Refer to figure 6-35 and assemble the reverse power relay in position using four screw assemblies. Refer to figure 1-13 and reconnect wiring. Replace the tactical relay box and cover.

6-142 through 6-146 deleted.

## 6-147. SHORT CIRCUIT RELAY (K13).

## 6-148. TEST ON EQUIPMENT.

a. Symptom and Isolation of Malfunction. A malfunction of the short circuit relay K13 is usually indicated by failure of the generator fault monitoring system to detect and react to a rise in generator current output (in any phase) beyond preset limits. To isolate the malfunction, proceed as follows.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

NOTE

Remove cover from tactical relay box to gain access to test points, see figures 6-14 and 6-35.

1. With the generator set at rated speed and voltage, and with the contactor closed, measure the voltage from terminals 8 and 5 (+) of the K13 relay to TB 2-5 (-). Voltage should read 20-32 VDC.

2. Apply 100 percent of rated load and measure the voltage from terminals 1-4, 2-4 and 3-4 of short circuit relay K13. Voltage should read 5.6 ± 0.5 VAC. If the preceding conditions are met and the short circuit relay K13 does not actuate with application of a short circuit, replace the K13 relay.

b. Removal. Refer to figure 6-35 and tag, then disconnect wiring at the short circuit relay terminals. Remove the four screw assemblies securing the relay in position.

### 6-149. OFF EQUIPMENT TEST.

(a) Connect a light and a 24 Vdc power supply in series with terminals 5 and 6 (DS1), also with terminals 7 and 8 (DS2). Relay trip will be indicated by the two lights. DS1 shall extinguish; DS2 shall light. See figure 8-8 for test setup.

(b) Connect a variable (0 to 120 volts) ac voltage source (50 to 400 Hz) between terminals 1 and 4 and slowly increase the voltage. The relay shall transfer lights when voltage equals 24 volts ± 1 volt. Repeat the test with the input connected to 2 and 4, and then again, between 3 and 4 by moving switch S2. The trip points should be within 1 volt of each other.

(c) Terminals 5, 6, 7, 8 and terminals 1, 2, 3, 4 shall be electrically isolated with the relay in either position.

Pages 6-108 and 6-109, figures 6-40 and 6-41 deleted.

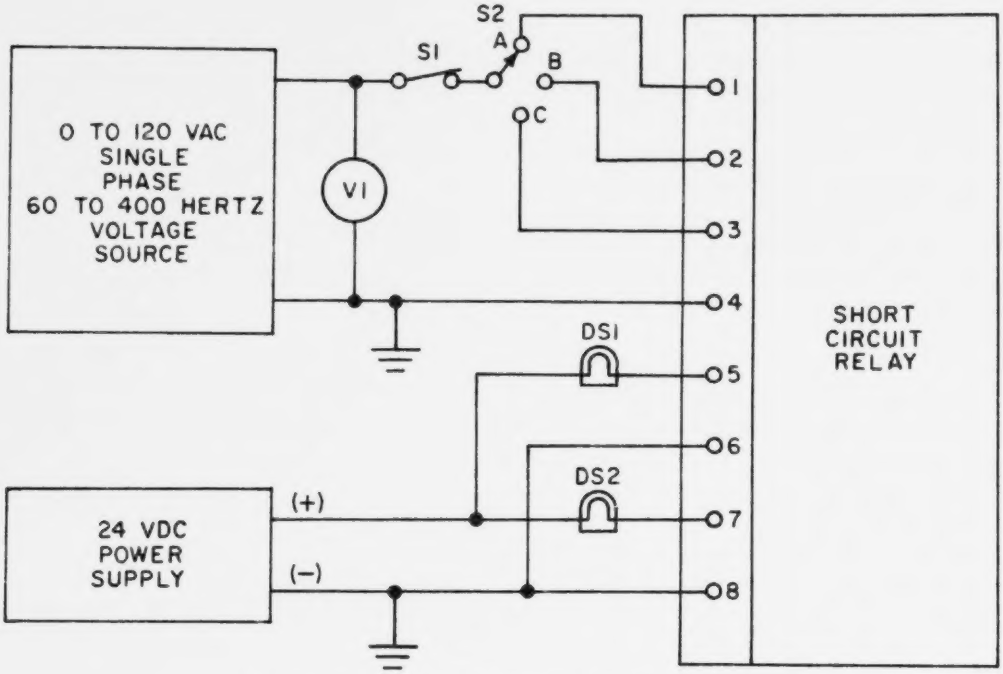


Figure 6-42. Short Circuit Relay (K13)

6-150. INSTALLATION. Refer to figure 6-35 and assemble the short circuit relay in position using four screw assemblies. Refer to figure 1-13 and reconnect wiring. Replace the tactical relay box and cover.

6-151 thru 6-155 deleted

6-156. OVERLOAD RELAY (K14).

6-157. TEST ON EQUIPMENT.

a. Symptom and Isolation of Malfunction. A malfunction of the overload relay K14 is usually indicated by failure of the generator fault monitoring system to detect and react to a current rise in any phase, beyond preset limits. To isolate the malfunction, proceed as follows.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

NOTE

Remove cover from tactical relay box to gain access to test points, see figures 6-14 and 6-35.

1. With the generator set operating at rated speed and voltage, and with the contactor closed, the voltage measured across the plus (+) and minus (-) terminals of the overload relay K14 should read 20-32 VDC. The voltage from the NO terminal (wire P200X16) to TB2-5 and from the NC terminal (wire P62K16) to TB2-5 should read 20-32 VDC.

2. Apply 130 percent load to the generator set. The relay should activate in 8± 2 minutes. Determine that the unit current meter indicates 130% of current on all phases. No current reading would indicate an open current circuit. When the relay actuates a momentary dc voltage should be measured from the NO terminal (wire P209D16) to TB2-5 and there should be no dc voltage measured from the NC terminal (wire P62K16) to TB2-5. If the above conditions are not met, the K14 relay should be replaced.

Pages 6-111 and 6-112, including figure 6-43 deleted.

Legend to figure 6-43 deleted.

b. Removal. Refer to figure 6-35 and tag, then disconnect wiring at the overload relay terminals. Remove the four screw assemblies securing the relay in position.

### 6-158. OFF EQUIPMENT TEST

(a) Connect the relay in the test setup shown in figure 6-45.

(b) With the 120/208 Vac power source energized, turn on the 24 Vdc power supply and close switch S1. Lamp DS1 should light and DS2 should be extinguished.

(c) Adjust autotransformers T1, T2 and T3 until ammeters A1, A2 and A3 indicate 0.75 amperes, DS1 and DS2 should not change states.

(d) Adjust autotransformer T1 until ammeter A1 indicates 0.975 ampere. After ± 2 minutes, DS1 and DS2 should transfer states.

(e) Repeat paragraph (d) for autotransformers T2 and T3. The test results should be the same as for T1. Repeat paragraph (d) for all 3 autotransformers. The test results should be the same.

6-159. INSTALLATION. Refer to figure 6-35 and assemble the overload relay in position using four screw assemblies. Refer to figure 1-13 and reconnect wiring. Replace the tactical relay box and cover.

### 6-160. TACTICAL RELAY BOX (A29).

### 6-161. TEST ON EQUIPMENT.

a. Symptom and Isolation of Malfunction. A malfunction of the tactical relay box is usually indicated by a failure of the overvoltage relay, reverse power relay, short circuit relay, and overload relay. To isolate the malfunction, refer to figure 1-12 and proceed as follows.

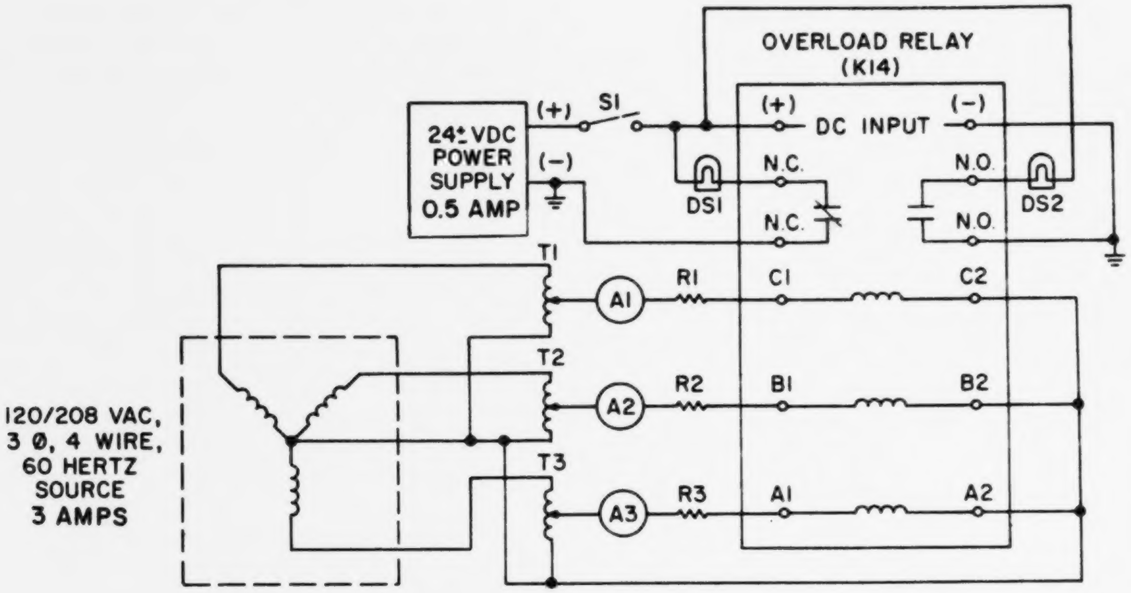
WARNING

Exercise extreme care not to touch exposed electrical connection when working inside tactical relay box with generator set operating.

NOTE

Remove cover from tactical relay box to gain access to test points, see figures 6-14 and 6-35.

Page 6-114, figure 6-44 deleted.


OVERLOAD RELAY
(K14)
24± VDC
POWER
SUPPLY
0.5 AMP
(+)
(−)
S1
DS1
DS2
(+)
DC INPUT
(−)
N.C.
N.C.
N.O.
N.O.
T1
T2
T3
A1
A2
A3
R1
R2
R3
C1
C2
B1
B2
A1
A2
120/208 VAC,
3 Ø, 4 WIRE,
60 HERTZ
SOURCE
3 AMPS

NOTES:

1. RESISTORS R1, R2 AND R3 ARE 35 OHM, 50 WATT RESISTORS
2. T1, T2 AND T3 ARE AUTOTRANSFORMERS WITH 2 AMP RATING

Figure 6-45. Overload relay (K14), test setup

1. To isolate a malfunction of the overvoltage relay, refer to paragraph 6-130.

2. To isolate a malfunction of the reverse power relay, refer to paragraph 6-139.

3. To isolate a malfunction of the short circuit relay, refer to paragraph 6-148.

4. To isolate a malfunction of the overload relay, refer to paragraph 6-157.

b. Removal. Refer to figure 6-14, disconnect the two electrical plug connectors at the tactical relay box receptacles, then remove the two screws and washers securing the box in position. Remove the tactical relay box.

6-162. TEST.

a. Refer to table 6-16 and perform a continuity test of the tactical relay box.

b. Connect the tactical relay box to test equipment as illustrated in figure 6-46

Table 6-16. Tactical Relay Box (A29) Continuity Test

| FROM CONNECTOR J51 | TO CONNECTOR J4 | REQUIRED RESULT |
|---|---|---|
| S | A | Continuity |
| R | B | Continuity |
| d | G | Continuity |
| V | F | Continuity |
| U | E | Continuity |
| T | D | Continuity |
| X | N | Continuity |
| N | S | Continuity |
| J | C | Continuity |
| K | M | Continuity |
| K | K | Continuity |
| K | L | Continuity |

and perform test specified in procedural analysis table 6-17.

6-163. DISASSEMBLY. Disassemble the tactical relay box to the extent necessary to accomplish repair. Refer to figures 6-35 and 6-47 and disassemble in the order of index numbers assigned. Pay particular attention to the following.

NOTE

Remove the four screws and washers securing the cover to the relay chassis.

a. Tag, then disconnect harness wiring from components.

b. Remove overvoltage relay (K2), overload relay (K14), short circuit relay (K13) and reverse power relay (K15) from the chassis by removing their attaching screw assemblies (4 each).

NOTE

Refer to paragraphs 6-129, 6-156, 6-147, and 6-138, respectively, for relay maintenance instructions.

c. Remove terminal board (TB2), governor resistor assembly (20), and mounting bracket (31) as an assembly by removing screw assembly (30).

d. Remove the wire harness (6) from the chassis by removing eight screw assemblies (2 and 3) and nuts (4 and 5).

6-164. CLEANING. Clean all components with a lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

6-165. INSPECTION AND TEST.

a. Harness.

1. Inspect harness wiring for defective insulation and continuity.

2. Inspect harness connectors for damaged threads; bent, loose or missing pins, and for shorts.

b. Inspect resistors R23, R24, and R25 for rated resistance; 7.5 Ω ± 1 percent, 10 watts.

c. Inspect terminal board (TB2) for cracks and missing hardware.

6-166. REPAIR.

a. Repair or fabricate tactical relay box wire harness in accordance with figure 6-48.

Legend to figure 6-46:

| | |
|---|---|
| A7 | Load Resistor Assembly, Current Transformer |
| A7R23 | Resistor, Fixed |
| A7R24 | Resistor, Fixed |
| A7R25 | Resistor, Fixed |
| AM1 | Meter, Ampere |
| AM2 | Meter, Ampere |
| AM3 | Meter, Ampere |
| DS1 | Lamp, Indicating |
| DS2 | Lamp, Indicating |
| DS3 | Lamp, Indicating |
| DS4 | Lamp, Indicating |
| DS5 | Lamp, Indicating |
| DS6 | Lamp, Indicating |
| DS7 | Lamp, Indicating |
| J4 | Connector, Receptacle |
| J51 | Connector, Receptacle |
| K2 | Relay, Overvoltage |
| K13 | Relay, Short Circuit |
| K14 | Relay, Overload |
| K15 | Relay, Reverse Power |
| P51 | Connector, Plug |
| S1 | Switch, Toggle |
| S2 | Switch, Toggle |
| S3 | Switch, Toggle |
| S4 | Switch, Toggle |
| S5 | Switch, Toggle |
| VM1 | Meter, Volt |
| VM2 | Meter, Volt |
| | Power Supply, 24 VDC, 2 Amp |
| | Power Supply, 0-10 VDC, 0.5 Amp |
| | Power Supply, 0-160 VAC, 50/60 Hz, 1 Amp |
| | Power Supply, 0-50 VAC, 3 Phase, 50/60 Hz, 4 wire, 5 Amp |

Table 6-17. Tactical Relay Box (A7) Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 1. | Energize 24 VDC power supply. | Indicator lights DS3, DS4 and DS7 should light. | | |
| 2. | Energize 0-10 VDC power supply. | | | |
| 2. a. | Position switch S5 so that J51-X is positive, then slowly adjust voltage from 0 to 10 VDC; return voltage to 0 VDC. | Indicator light DS4 should stay energized. | Defective reverse power relay K15. | Test relay in accordance with paragraph 6-140. |
| 2. b. | Position switch S5 so that J51-N is positive, then slowly increase voltage to 3 ± 0.5 VDC; return voltage to 0 VDC. | Indicator light DS4 should extinguish and DS5 should light. | Same as step 2. a. | Same as step 2. a. |

Table 6-17. Tactical Relay Box (A7) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 3. | Energize 0-160 VAC power supply. | | | |
| 3. a. | Adjust voltage to 156 VAC and close switch S4. | Indicator light DS3 should extinguish and DS2 should light. | Defective over voltage relay K2. | Test relay in accordance with paragraph 6-131. |
| 3. b. | Deenergize 0-160 VAC power supply. | | | |
| 4. | Energize 0-50 VAC power supply. Close Close switches S1, S2 and S3, then adjust power supply to obtain 3.375 amperes on Ammeters AM1, AM2 and AM3. Open switches S1, S2, and S3. | | | |
| 4. a. | Close switches S1 and S2 and S3 in turn. | Indicator light DS7 should deenergize and DS6 energize as each switch is closed and opened. | Defective short circuit relay K13. | Test relay in accordance with paragraph 6-149. |

Table 6-17. Tactical Relay Box (A29) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 4.b. | Reduce voltage to 0 VAC. | | | |
| 5. | Close switches S1, S2 and S3, then adjust 0-50 VAC power supply to obtain 0.75 amperes. | | | |
| 5.a. | Adjust A phase voltage to obtain 0.957 ampere on AM1. | Indicator light DS4 should extinguish and DS1 should light within 8 ± 2 seconds. | Defective overload relay K14. | Test relay in accordance with paragraph 6-158. |
| 5.b. | Repeat step 5.a. for Phase B and C. | Same as step 5.a. | Same as step 5.a. | Same as step 5.a. |
| 5.c. | Turn off all power supplies. | | | |

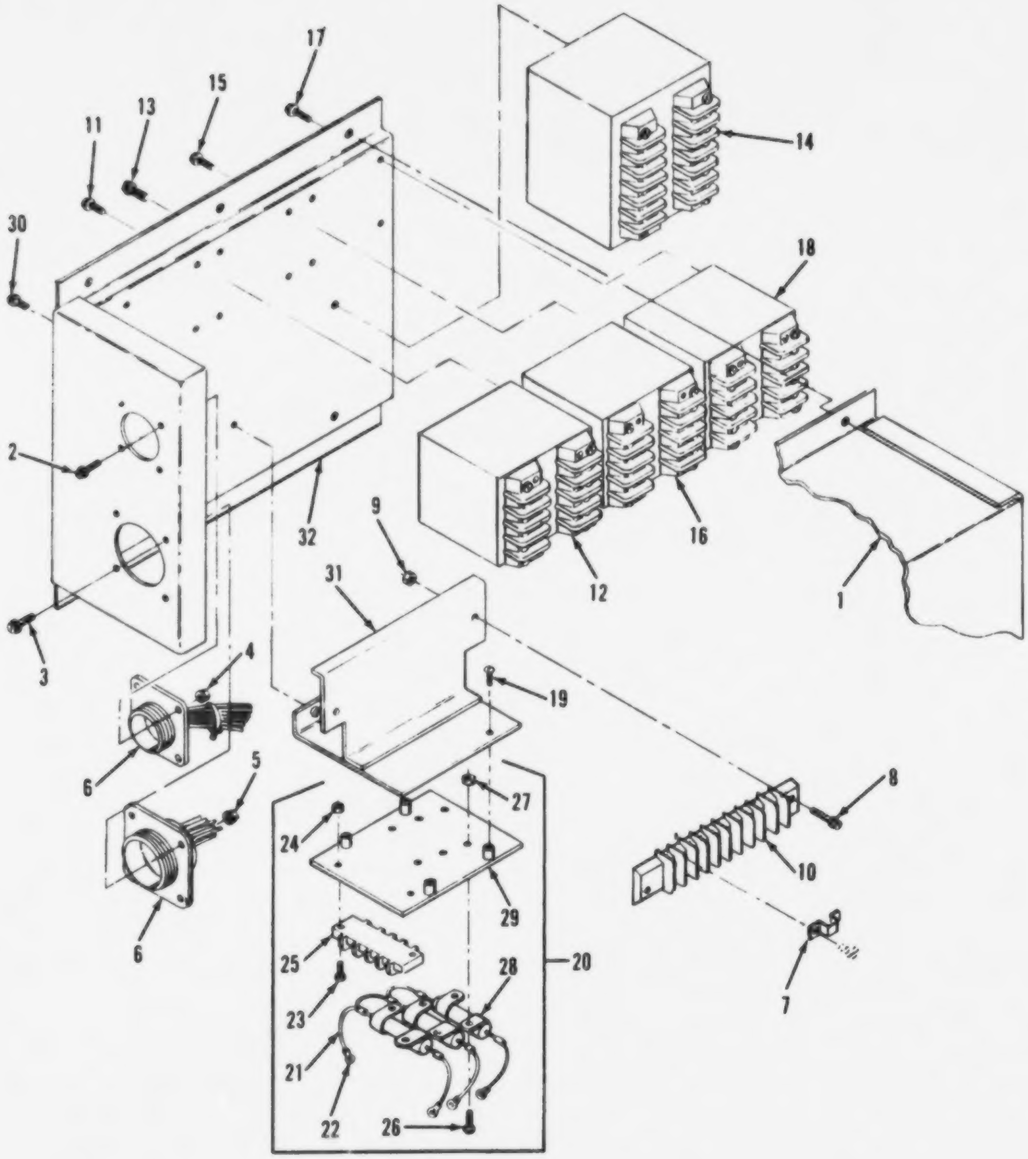

17
15
13
11
30
14
18
2
32
16
12
1
9
31
3
4
19
6
5
8
27
24
29
10
6
25
28
20
23
7
21
22
26

Figure 6-47. Tactical relay box (A29), exploded view

Legend to figure 6-47:

1. Cover
2. Screw assembly (4)
3. Screw assembly (4)
4. Nut (4)
5. Nut (4)
6. Harness assembly
7. Jumper
8. Screw assembly (2)
9. Nut assembly (2)
10. Terminal board
11. Screw assembly (4)
12. Over voltage relay (K2)
13. Screw assembly (2)
14. Overload relay (K14)
15. Screw assembly (4)
16. Short circuit relay (K13)
17. Screw assembly (4)
18. Reverse power relay
19. (K15)
20. Screw assembly (2)
Governor resistor assembly
21. Wire
22. Terminal lug (4)
23. Screw (2)
24. Nut assembly (2)
25. Terminal board TB2
26. Screw (6)
27. Nut (6)
28. Resistor (R1, R2, R3)
29. Mount
30. Screw assembly (6)
31. Bracket
32. Chassis assembly

b. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with a suitable abrasive paper and touch up painted surfaces. Restencil panel markings as necessary.

6-167. REASSEMBLY. Refer to figures 6-35 and 6-47 and reassemble the tactical relay box in reverse order of index numbers assigned. Pay particular attention to the following.

a. Install wire harness (6) in chassis assembly (32) and secure in position with eight screw assemblies (2 and 3) and nuts (4 and 5).

b. Assemble governor resistor assembly (20) and terminal board (10) to bracket (31), then install the assembly in chassis assembly (32).

c. Assemble overvoltage relay (12). overload relay (14, short circuit relay (16), and reverse power). relay (18) in position using four each screw assemblies.

d. Refer to figures 6-48 and 1-13 and connect wire harness leads to componentry.

e. Test tactical relay box as outlined in paragraph 6-162.

f. Secure cover (1, figure 6-47) to chassis assembly (32) using four screw assemblies (17).

6-168. INSTALLATION. Refer to figure 6-14 and install the tactical relay box in position using two screws and washers. Reconnect electrical plug connector to receptacles J4 and J51.

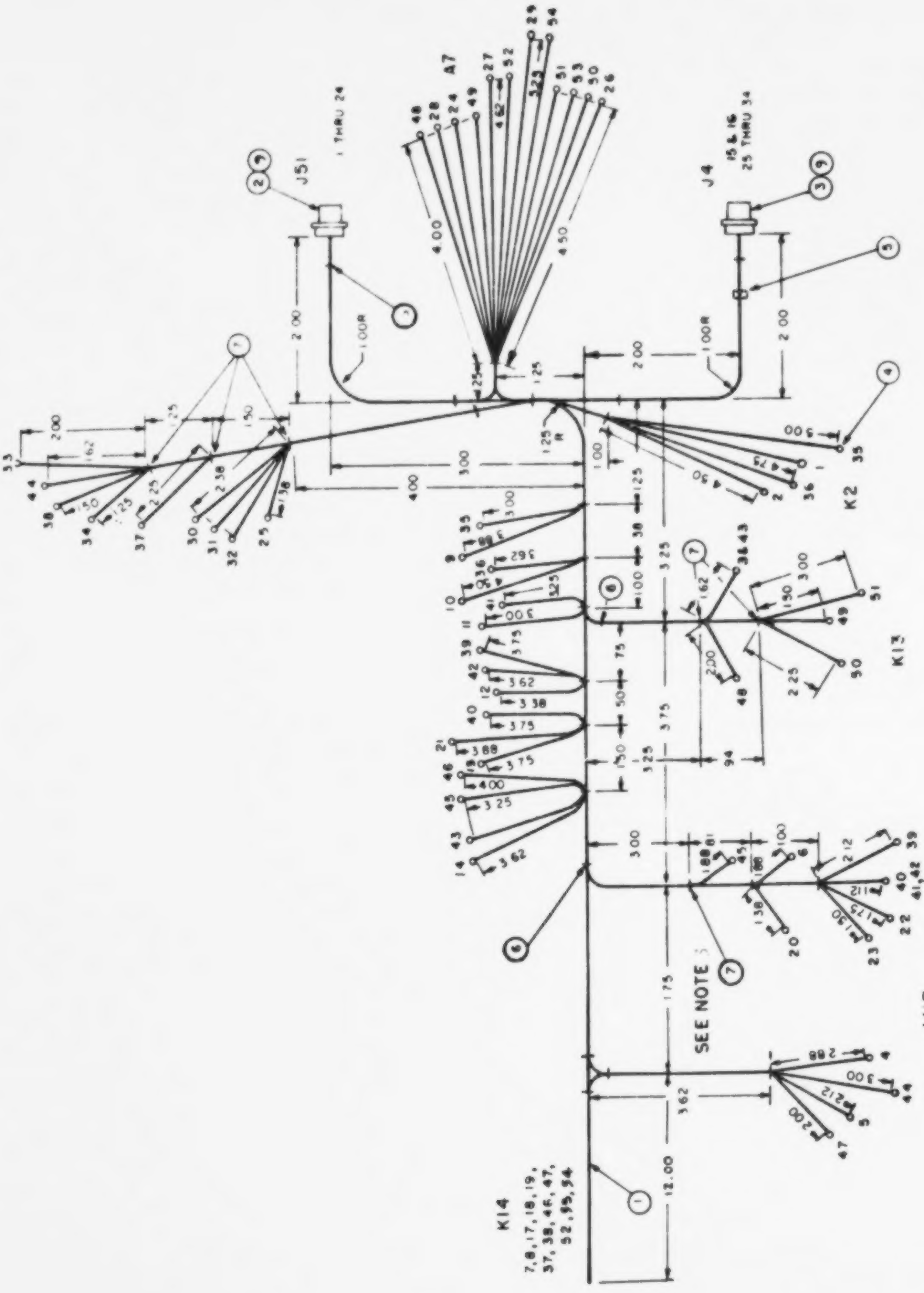

TB2
J51
1 THRU 24
A7
J4
15 & 16
25 THRU 34
K2
K13
K14
7,8,17,18,19,
37,38,46,47,
52,55,54
K15
SEE NOTE 3
12.00

Figure 6-48. Tactical relay box (A29), wiring harness (sheet 1 of 2)

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | P58D16 | J51-A | 2 | K2-3 | 4 | 10.00 |
| 2 | BLACK | P50T16 | J51-B | ↑ | K2-4 | 4 | 10.00 |
| 3 | BLACK | P206D16 | J51-C | | K2-7 | 4 | 12.25 |
| 4 | BLACK | P205D16 | J51-D | | K15-6 | 4 | 18.25 |
| 5 | BLACK | P60A16 | J51-E | | K15-7 | 4 | 17.75 |
| 6 | BLACK | P203D16 | J51-F | | K13-7 | 4 | 15.75 |
| 7 | BLACK | P209D16 | J51-G | | K14-NO | 4 | 26.00 |
| 8 | BLACK | P62K16 | J51-H | | K14-NC | 4 | 26.00 |
| 9 | BLACK | X9W16 | J51-J | | TB2-1 | 4 | 8.75 |
| 10 | BLACK | X12CC16 | J51-K | | TB2-2 | 4 | 9.25 |
| 11 | BLACK | P50BB16 | J51-L | | TB2-4 | 4 | 9.75 |
| 12 | BLACK | P55BB16 | J51-M | | TB2-5 | 4 | 10.25 |
| 13 | BLACK | K102D16 | J51-N | | TB2-6 | 4 | 11.00 |
| 14 | BLACK | P200U16 | J51-P | | TB2-8 | 4 | 12.50 |
| 15 | BLACK | X8K16 | J51-R | | J4-B | 3 | 8.00 |
| 16 | BLACK | X7K16 | J51-S | | J4-A | 3 | 8.00 |
| 17 | BLACK | X17E16 | J51-T | | K14-A1 | 4 | 26.00 |
| 18 | BLACK | X18E16 | J51-U | | K14-B1 | 4 | 26.00 |
| 19 | BLACK | X19E16 | J51-V | | K14-C1 | 4 | 26.00 |
| 20 | BLACK | P55BH16 | J51-W | | GRDLUG | 4 | 17.00 |
| 21 | BLACK | K101D16 | J51-X | | TB2-7 | 4 | 11.50 |
| 22 | BLACK | P63A16 | J51-a | | K13-5 | 4 | 16.50 |
| 23 | BLACK | P62F16 | J51-b | ↓ | K13-6 | 4 | 16.50 |
| 24 | BLACK | D24F16 | J51-d | 2 | A7-TB1-4 | 4 | 7.50 |
| 25 | BLACK | X9Y16 | J4-C | 3 | TB2-1 | 4 | 9.50 |
| 26 | BLACK | X116B16 | J4-E | 3 | A7-TB1-2 | 4 | 10.00 |
| 27 | BLACK | X117B16 | J4-F | 3 | A7-TB1-3 | 4 | 10.00 |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 28 | BLACK | D24J16 | J4-G | 3 | A7-TB1-4 | 4 | 9.50 |
| 29 | BLACK | X115B16 | J4-D | ↑ | A7-TB1-1 | 4 | 10.50 |
| 30 | BLACK | X12HH16 | J4-K | | TB2-3 | 4 | 10.00 |
| 31 | BLACK | X12KK16 | J4-L | | TB2-3 | 4 | 10.00 |
| 32 | BLACK | X12DD16 | J4-M | | TB2-2 | 4 | 10.50 |
| 33 | BLACK | K101B16 | J4-N | ↓ | TB2-7 | 4 | 12.50 |
| 34 | BLACK | K102B16 | J4-S | 3 | TB2-6 | 4 | 12.00 |
| 35 | BLACK | X9X16 | TB2-1 | 4 | K2-1 | 4 | 10.25 |
| 36 | BLACK | X12FF16 | TB2-2 | 4 | K2-2 | 4 | 11.00 |
| 37 | BLACK | P50DD16 | TB2-4 | 4 | K14-(+) | 4 | 28.50 |
| 38 | BLACK | P55JJ16 | TB2-5 | 4 | K14-(-) | 4 | 29.00 |
| 39 | BLACK | K102C16 | TB2-6 | 4 | K15-1 | 4 | 12.00 |
| 40 | BLACK | K101C16 | TB2-7 | 4 | K15-2 | 4 | 12.00 |
| 41 | BLACK | P50CC16 | TB2-4 | 4 | K15-3 | 4 | 13.00 |
| 42 | BLACK | P55NN16 | TB2-5 | 4 | K15-4 | 4 | 12.50 |
| 43 | BLACK | P200Z16 | TB2-8 | 4 | K2-8 | 4 | 10.00 |
| 44 | BLACK | P200Y16 | TB2-8 | 4 | K15-5 | 4 | 23.00 |
| 45 | BLACK | P200W16 | TB2-9 | 4 | K13-8 | 4 | 10.00 |
| 46 | BLACK | P200X16 | TB2-9 | 4 | K14-NO | 4 | 19.00 |
| 47 | BLACK | P61A16 | K15-8 | 4 | K14-NC | 4 | 18.00 |
| 48 | BLACK | D24H16 | A7-TB1-4 | 4 | K13-4 | 4 | 13.75 |
| 49 | BLACK | X117D16 | A7-TB1-3 | 4 | K13-3 | 4 | 14.50 |
| 50 | BLACK | X116D16 | A7-TB1-2 | 4 | K13-2 | 4 | 16.75 |
| 51 | BLACK | X115D16 | A7-TB1-1 | 4 | K13-1 | 4 | 16.50 |
| 52 | BLACK | X117C16 | A7-TB1-3 | 4 | K14-C2 | 4 | 28.00 |
| 53 | BLACK | X116C16 | A7-TB1-2 | 4 | K14-B2 | 4 | 28.00 |
| 54 | BLACK | X115C16 | A7-TB1-1 | 4 | K14-A2 | 4 | 28.50 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | | | TYPE F FORM Ua GRADE a CL I CATEGORY 1 | 34 | TUBING, INSULATION .106 ID X .016 WALL X .62 LG | MIL-I-631 | |
| 8 | | | SN60WRAP3 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-751 | |
| 7 | | | MS3367-4-9 | 8 | STRAP, TIEDOWN | | NYLON |
| 6 | | | MS3367-1-9 | 19 | STRAP, TIEDOWN | | NYLON |
| 5 | | | MS39020-1 | 1 | BAND, MARKER | | AL ALY |
| 4 | | | MS25036-106 | 72 | TERMINAL, LUG, CRIMP STYLE | | |
| 3 | | | MS3102R20-29P | 1 | CONNECTOR, PLUG | | |
| 2 | | | MS3102R28-12P | 1 | CONNECTOR, PLUG | | |
| 1 | | | MS5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

NOTES:
1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 8
3. CABLE STRAPS, FIND NO. 6 AND 7, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. TACTICAL RELAY BOX (A7) WIRING HARNESS IS DOD P/N 30554-70-4211.

Figure 6-48. Tactical relay box (A29), wiring harness (sheet 2 of 2)

## Section IX. PRECISE RELAY BOX

### 6-169. GENERAL.

The precise relay box (A25) is used only for precise generator sets. It contains the under frequency relay, under voltage relay, permissive paralleling relay, frequency mode selector switch, governor paralleling control or load sharing rheostat, governor feedback capacitor, and the frequency adjust device fixed resistors. (Refer to schematic diagram, figure 1-14.)

a. The under frequency relay (K12) is a solid state device which functions to protect the load in the event generator frequency decreases below preset limits. It actuates when frequency decreases to 55 ± 1 hertz for 60 hertz operation and 46 ± 1 hertz for 50 hertz operation. Upon actuation, contacts within the underfrequency relay, close to signal the fault locator and open to deenergize the load contactor, resulting in display of the fault condition and removal of the load from the generator.

1. Frequency sensing is accomplished by means of a tuned circuit consisting of capacitors (C1 and C2) and components in the encapsulated base. Zener diodes CR1, CR2, and CR3 limit the peak voltage to the tuned circuit. The ac output of the tuned circuit is rectified by diode CR4 and applied to a voltage divider consisting of resistors R1, R2, R3, and R4. Transistor Q1 compares the voltage at the wiper of potentiometer R3 with the reference voltage established by zener diode CR7. When transistor Q1 conducts, transistor Q2 is biased for conduction also. Transistor Q2 operates as a switch to control the coil voltage on a relay contained in the encapsulated base. Both transistors Q1 and Q2 and the relay in the encapsulated base are energized when the frequency of the input voltage to terminals 1 and 2 is normal frequency (50/60 hertz). When an under frequency condition occurs, the voltage at the base of transistor Q1 is not sufficient for conduction, and the relay is deenergized and its contacts switch.

2. The under frequency trip point is adjusted by potentiometer R3 for 60 hertz operation. For 50 hertz operation, pins 7 and 8 are shorted by switch S10. Potentiometer R2 (figure 1-14) adjusts the frequency trip point.

b. The under voltage relay (K11) is a solid state device which functions to protect the load in the event generator voltage decreases below preset limits. It senses single phase 120 VAC. The time lag between an under voltage condition and activation of relay switching depends upon the magnitude of the voltage sensed. When the input voltage drops below 48 VAC, the device shall operate instantaneously. For voltages above 72 VAC, the device shall operate in 6 ± 2 seconds. Upon actuation, contacts within the under voltage relay, close to signal the fault locator and open to deenergize the load contactor, resulting in display of the fault condition and removal of the load from the generator.

1. The single phase input voltage is rectified by diode (CR2) and applied to a sampling network consisting of resistors R1, R2, and R3. The dc voltage sampled at the wiper of potentiometer R2 is filtered by capacitor C4. Transistor Q1 compares the sample voltage on capacitor C4 to a reference voltage obtained by zener diode CR3.

2. When the input voltage is above the trip point, transistor Q1 is conducting. This causes zener diode CR1 to limit the

voltage across capacitors C1, C2, and C3 to 15 volts. This voltage forward biases transistors Q2 and Q3 for conduction. Transistors Q2 and Q3 function as a switch to energize a relay contained in the encapsulated base.

3. When the input voltage is below the trip point, or approximate the zener breakdown voltage of CR3 then transistor Q1 will turn off. When this happens, the capacitors discharge through resistors R6 and R8, and zener diode CR6. When the voltage across these capacitors falls below the zener breakdown voltage of CR6, transistors Q2 and Q3 will turn off. This deenergizes the relay.

4. Diodes CR7 through CR10 are utilized as a full wave bridge to rectify the input voltage to a dc level for the detector circuit and the relay. Capacitor C5 reduces the ripple of the rectified voltage to prevent relay chatter.

c. The permissive paralleling relay (K16) is utilized only on precise generator sets. Its function is to ensure that a generator set cannot be paralleled with other generator sets until synchronization is accomplished. It accomplishes this by sensing the voltage drop across one of the synchronization lights. When the voltage exceeds 9 VAC, the relay contacts are open. When the voltage is less than 7 VAC, its contacts close. Since its contacts are connected between the load contactor switch S3 and the load contactor relay coil CB2, it will allow or prevent the contactor from being energized. When this generator set is perfectly synchronized with the other sets, the voltage across the synchronizing lights will be minimum (less than 7 VAC). This causes the permissive paralleling relay to close its contacts and allow the generator set to be paralleled with other generator sets by closing of its load contactor switch S3. If the generator set is not perfectly synchronized, the voltage across the synchronizing lights will be above 9 VAC. This causes the permissive paralleling relay to have its contacts open and prevents the load contactor CB2 from closing.

1. The ac voltage across the synchronization light is rectified by diode CR1 and applied to a voltage divider network consisting of resistors R2, R3, and R4. Transistor Q3 compares the sampled voltage at the wiper of R3 with the voltage necessary for silicone unilateral switch Q4 to conduct.

2. When the input voltage is sufficient to cause transistor Q3 to conduct; the ac component of the rectified voltage will pass through resistor R1, transformer, and through Q3 and Q4. The secondary of the transformer applies its ac voltage to diode CR2. Diode CR2 rectifies this ac voltage and capacitor C1 smooths it before application to darlington pair Q1 and Q2. This pair acts as a switch in series with the relay K1. Q1 and Q2 are now conducting, causing relay K1 to be energized by the voltage applied to terminals 4 and 5. Diode CR3 acts to attenuate the inherent energy in the relay coil K1 after the darlington pair is deenergized.

d. The electronic components assembly (A6) consists of C1, R4, and R5. The assembly connects to the governor control unit and acts as a feedback circuit to provide the governor with greater frequency stabilization.

e. The governor paralleling control is a rheostat (R28) which permits initial matching of the governor paralleling circuits for sets operating in parallel. Its function is to ensure proper real load sharing. It has a slotted shaft with locking

Service which when rotated counterclockwise will cause an increase in signal appearing at paralleling receptacles, causing the generator to assume a greater share of the load.

## 6-170. 50/60 HERTZ UNDER FREQUENCY RELAY (K12).

## 6-171. TEST ON EQUIPMENT.

a. Symptom and Isolation of Malfunction. A malfunction of the underfrequency relay K12 is usually indicated by the illumination of the UNDER FREQUENCY fault light or by failure of the load contactor to close with the generator output frequency normal. To isolate the malfunction, proceed as follows.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside precise relay box with generator set operating.

NOTE

Remove cover from precise relay box to gain access to test points, see figures 6-14 and 6-49.

1. With the generator set at rated speed and voltage, measure the voltage from terminal 1 to terminal 2 of the K12 relay. Nominal voltage is 120 VAC.

2. If the voltage at terminal 1 and 2 is normal and fault light is still illuminated, remove the wire from terminal 6 of K12 relay and reset fault lamp. If fault lamp can be reset, relay K12 is defective.

3. If the voltage at terminals 1 and 2 is normal and the contactor CB2 will not close, measure the voltage from terminal 3 of K12 to TB3-1. Voltage should read 20-32 VDC, with the contactor switch S3 in the closed position. Measure the voltage from terminal 4 of K12 to TB3-1. Voltage should read 20-32 vdc with the contactor switch S3 in the closed position. If no voltage is present, replace relay K12.

4. Reduce frequency below 54 Hz (45 Hz for 50 Hz sets); relay should trip. If not, replace relay.

b. Removal. Refer to figure 6-49 and tag, then disconnect wiring to the under frequency relay. Remove the four screw assemblies securing the relay in position.

## 6-172. TEST OFF EQUIPMENT.

(a) Connect an external switch across terminals 7 and 8. Close switch.

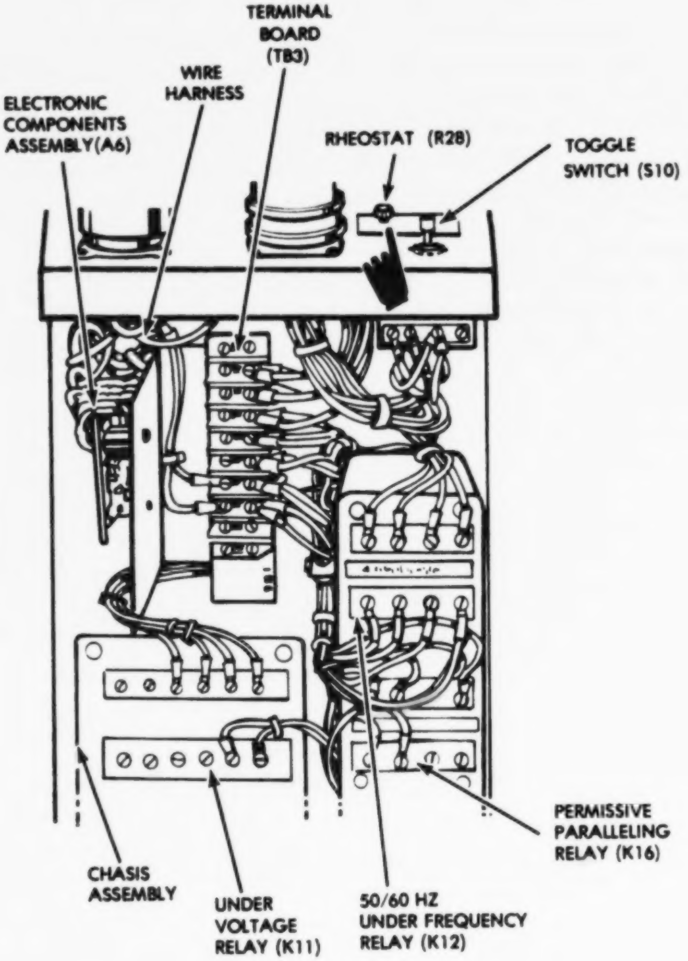
(b) Adjust the frequency to 50 Hz and the input voltage to 120 volts. Relay contacts should pick up; lamp DS1 should light and DS2 should extinguish.

(c) Lower frequency slowly until relay contacts drop out (lights transfer). Contacts should drop out 46 ± 1 Hz.

(d) Raise frequency slowly until contacts pick up (DS1 should light and DS2 should extinquish). Contacts should pick up at 45 to 49 Hz.

(e) Raise voltage to 132 volts and check for drop out (lights transfer). Drop out should occur within ± 1 Hz of drop out at 120 volts.

(f) Lower voltage to 108 volts. Drop out (lights transfer) should occur within ± 1 Hz of drop out at 120 volts.


TERMINAL BOARD (TB3)
WIRE HARNESS
ELECTRONIC COMPONENTS ASSEMBLY(A6)
RHEOSTAT (R28)
TOGGLE SWITCH (S10)
PERMISSIVE PARALLELING RELAY (K16)
CHASIS ASSEMBLY
UNDER VOLTAGE RELAY (K11)
50/60 HZ UNDER FREQUENCY RELAY (K12)

NOTES:

1. REMOVE THE FOUR SCREWS AND WASHERS SECURING THE COVER TO THE CHASSIS TO GAIN ACCESS TO THE TEST POINTS.
2. PRECISE RELAY BOX MUST BE REMOVED FROM GENERATOR SET TO ACCOMMODATE REPLACEMENT OF RELAYS. TO REMOVE THE BOX ASSEMBLY, TAG AND DISCONNECT THE TWO ELECTRICAL PLUG CONNECTORS AT J8 AND J32, THEN REMOVE TWO SCREWS AND WASHERS SECURING THE BOX IN POSITION.
3. REPLACE ASSEMBLY BY REVERSING ABOVE PROCEDURES.

Figure 6-49. Precise relay box (A25) step precise generator sets, cover removed

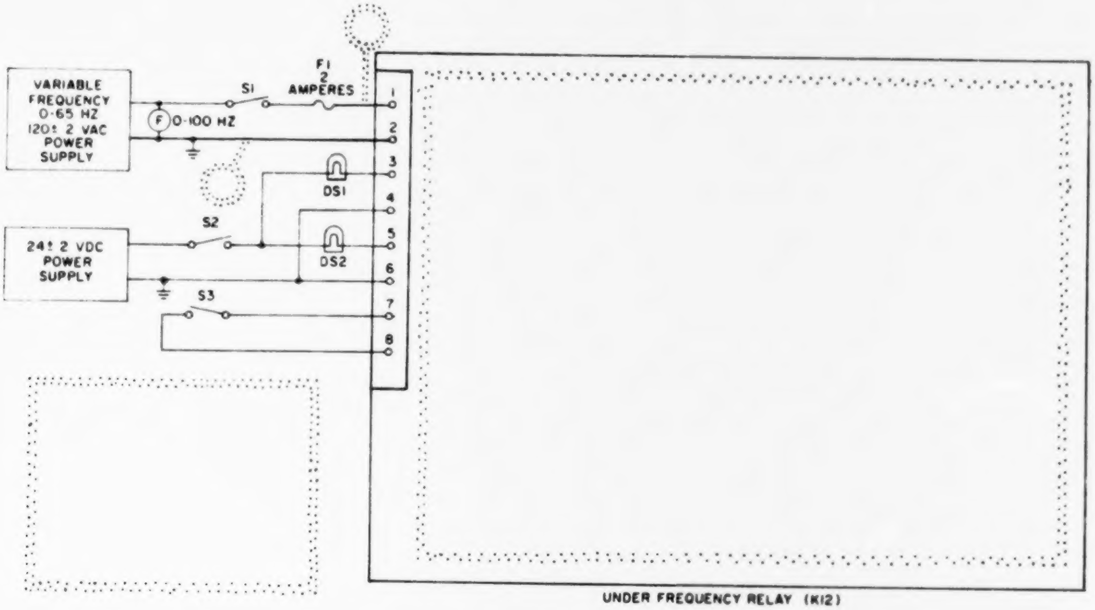

VARIABLE FREQUENCY 0-65 HZ 120± 2 VAC POWER SUPPLY
S1
F1 2 AMPERES
F
0-100 HZ
1
2
3
DS1
4
S2
5
24± 2 VDC POWER SUPPLY
DS2
6
S3
7
8
UNDER FREQUENCY RELAY (K12)

Figure 6-50. Under frequency relay (K12), test setup

All data on pages 6-131 thru 6-136, including figure 6-51 deleted.

6-173. INSTALLATION. Refer to figure 6-49 and install the under frequency relay in the precise relay box. Secure the relay in position with four screw assemblies, then refer to figure 1-15 and reconnect wiring. Replace precise relay box and cover.

6-174 thru 6-178 deleted

## 6-179. UNDERVOLTAGE RELAY (K11).

### 6-180. ON EQUIPMENT TEST.

a. Symptom and Isolation of Malfunction. A malfunction of the undervoltage relay K11 is usually indicated by the illumination of the UNDERVOLTAGE fault light, or by failure of the load contactor to close with the generator output voltage normal. To isolate the malfunction, proceed as follows.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside precise relay box with generator set operating.

NOTE

Remove cover from precise relay box to gain access to the test points, see figures 6-16 and 6-21

1. With the generator set operating at rated speed and voltage, measure the voltage from terminal 1 to terminal 2 of the K11 relay. The nominal voltage is 120 VAC. Remove the wire from terminal 3 of K11 and reset fault light. If fault light can now be reset, relay K11 is defective.

2. If the voltage at terminals 1 and 2 is normal and the contactor CB2 won't close, measure the voltage from terminal 7 of K11 to TB2-1. The voltage should read 20-32 VDC when the contactor switch S3 is placed in the close position.

3. Measure the voltage from terminal 8 of K11 to terminal board TB2-1. The voltage should read 20-32 VDC with contactor switch to the close position; if no voltage, replace K11 relay. The undervoltage relay should trip when the voltage is lowered below 99 ± 4 volts in 6 ±2 seconds.

b. Removal. Refer to figure 6-21 and tag, then disconnect wiring to the undervoltage relay. Remove the four screws securing the relay in position.

Page 6-138, figure 6-52 deleted.

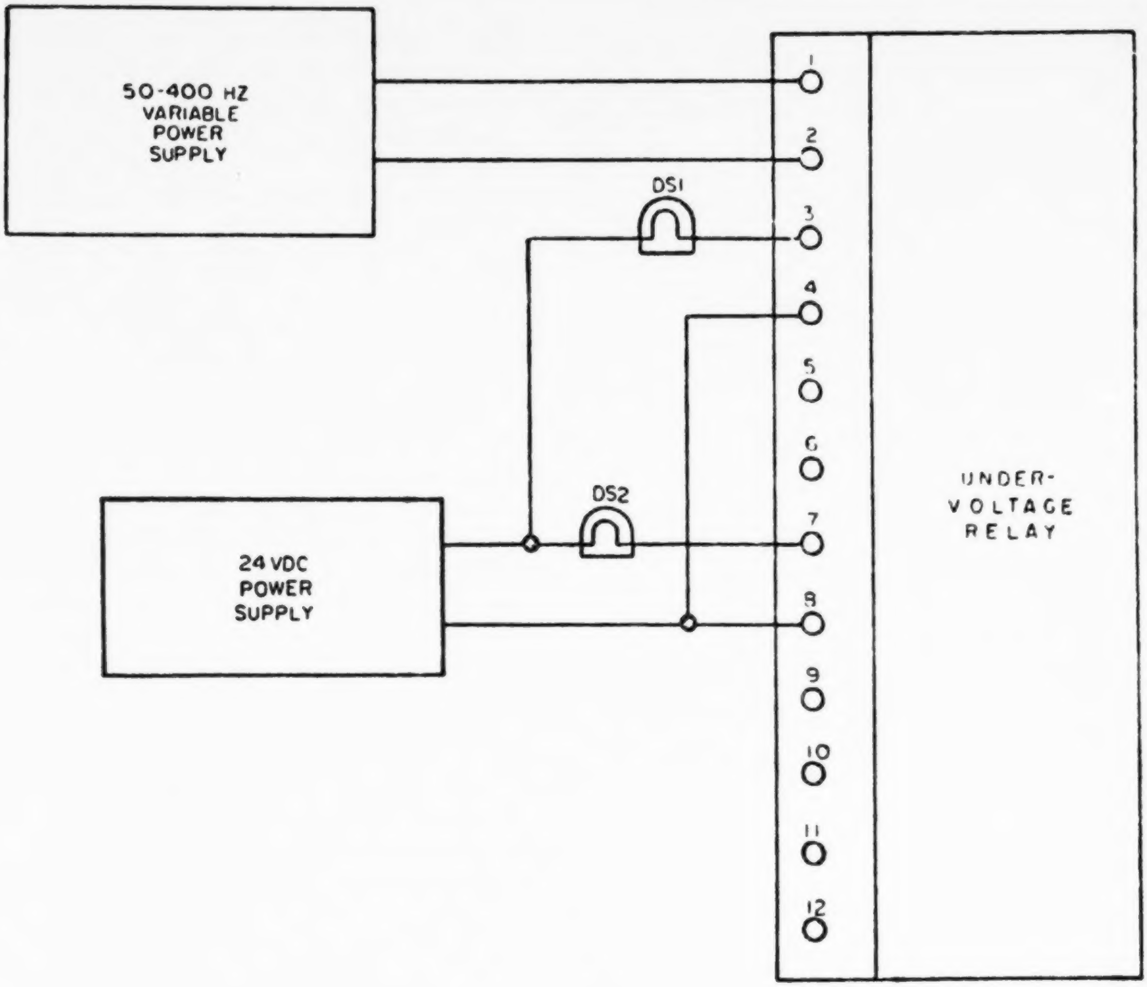

50-400 HZ VARIABLE POWER SUPPLY
24 VDC POWER SUPPLY
DS1
DS2
UNDER-VOLTAGE RELAY
1
2
3
4
5
6
7
8
9
10
11
12

Figure 6-53. Undervoltage Relay (K11), Test Setup

6-181. OFF EQUIPMENT TEST See figure 6-53.

(a) Adjust ac power supply to 130 volts, 400 Hz. Lamp DS1 should extinguish and DS 2 should light.

(b) Reduce voltage slowly to 104 volts and hold for 2 minutes. Lamp DS1 and DS2 shall maintain states.

(c) In one step, reduce voltage to 99 volts. DS1 and DS2 shall transfer states within 4 to 8 seconds.

(d) Increase voltage slowly to 113 volts. Lamps DS1 and DS2 shall transfer states.

(e) In one step, lower voltage to 48 volts. Transfer of states of DS1 and DS2 shall be instantaneous.

(f) Reduce frequency to 50 Hz and repeat the procedures in paragraphs (a) through (f) with the same results.

6-182. INSTALLATION. Refer to figure 6-21 and install the undervoltage relay in the precise relay box. Secure the relay in position with four screw assemblies, then refer to figure 1-15 and reconnect wiring. Replace precise relay box cover.

6-183 thru 6-187 deleted

### 6-188. PERMISSIVE PARALLELING RELAY (K16).

### 6-189. ON EQUIPMENT TEST.

a. Symptom and Isolation of Malfunction. A malfunction of the permissive paralleling relay K16 is usually indicated by the load contactor CB2 closing when the set voltage is out of phase with the buss voltage. To isolate the malfunction, proceed as follows.

**WARNING**

> Exercise extreme care not to touch exposed electrical connections when working inside precise relay box with generator set operating.

Page 6-144, figure 6-54 deleted.

NOTE

Remove cover from precise relay box to gain access to the test points, see figures 6-16 and 6-49.

1. Remove wire from terminal 7 of the K16 relay to prevent the contacts from closing. With the generator set operating at rated speed and voltage and the load buss energized by a second set, measure the voltage from terminal 3 to terminal 4 of the K16 relay. The voltage should read 20-32 VDC.

2. Measure the voltage from terminal 1 to terminal 2 of K16 with the contactor switch (S3) in the close position. Connect an ohmmeter across terminal 7 and 8 of K12. Observe that the ohmmeter does not read continuity when the voltage across terminals 1 and 2 is above 10 VAC; if the contacts close with a higher voltage, the K 16 is defective,

b. Removal. Refer to figure 6-49 and tag, then disconnect wiring to the permissive paralleling relay. Remove the four screws securing the relay in position.

## 6-190. OFF EQUIPMENT TEST See figure 6-56

(a) Apply 24 Vdc to terminals 3 (+) and 4(-).

b. Apply 20 volts, 400 Hz across terminals 1 and 2.

(c) Normally open contacts 5 and 6, and normally closed contacts 7 and 8 should transfer.

(d) (d) Slowly decrease the voltage at terminals 1 and 2. The relay must reset when the voltage is 8 ± 1 volt ac.

Page 6-146, figure 6-55 deleted.

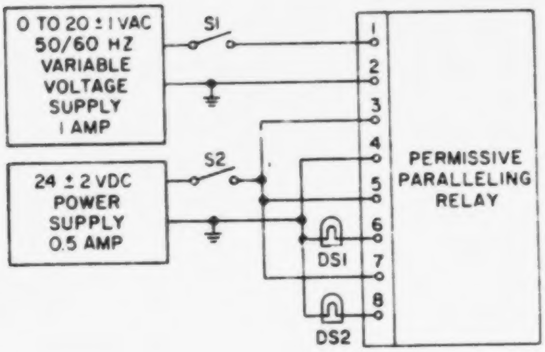

0 TO 20 ± 1 VAC
50/60 HZ
VARIABLE
VOLTAGE
SUPPLY
1 AMP
24 ± 2 VDC
POWER
SUPPLY
0.5 AMP
S1
S2
DS1
DS2
1
2
3
4
5
6
7
8
PERMISSIVE
PARALLELING
RELAY

Figure 6-56. Permissive paralleling relay (K16), test setup

6-191. INSTALLATION. Refer to figure 6-21 and install the permissive paralleling relay in the precise relay box. Secure the relay in position with four screw assemblies, then refer to figure 1-15 and reconnect wiring. Replace precise relay box cover.

6-192 through 6-196 deleted.

## 6-197. PRECISE ELECTRONIC COMPONENTS ASSEMBLY (A6).

## 6-198. TEST AND REMOVAL.

a. Symptom and Isolation of Malfunction. A malfunction of the electronic component assembly (A6) usually is indicated

All data on pages 6-148 through 6-150, including figure 6-57, deleted.

by an unstable generator frequency or by loss of frequency control. To isolate this malfunction, refer to figure 1-14 and proceed as follows.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside precise relay box with generator set operating.

NOTE

Remove cover from precise relay box to gain access to the test points, see figures 6-16 and 6-49.

1. To check for cause of unstable generator frequency, connect an ohmmeter, set to the R X 10,000 scale, to capacitor C1. The meter should indicate 0 resistance and slowly rise to infinite resistance. If capacitor C1 doesn't meet the above requirements, the capacitor is defective.

2. To check for lack of frequency control, measure the resistance of resistors R4 and R5. The resistance should be 249 ohms ± 1 percent, if not, the resistors are defective.

b. Removal. Refer to figure 6-49 and tag, then disconnect wiring to the electronic components assembly. Remove the three screw assemblies securing the assembly in position.

### 6-199. BENCH TEST.

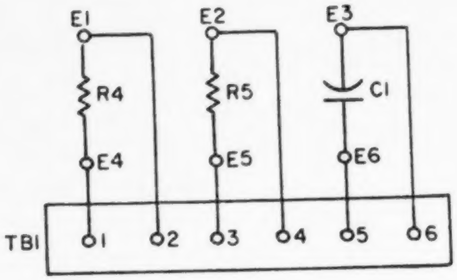
Using an ohmmeter, test the electronic components assembly for values as notes in figure 6-59.

NOTE

Figure 6-59 illustrates the electronic components assembly schematic and includes required values. If the required value is not obtained, replace the faulty component.

6-200. DISASSEMBLY. Refer to figure 6-60 and disassemble the electronic components assembly to the extent necessary to accomplish repair. Pay particular attention to the following.

Page 6-152, figure 6-58 deleted



| STEP | PROCEDURE | TEST POINT | REQUIRED RESULT |
|---|---|---|---|
| 1 | USE OHMMETER (R X 10K SCALE) | TB1-5 to TB1-6 | METER SHOULD READ 0 OHMS INITIALLY, THEN SLOWLY RISE TO INFINITY. |
| 2 | USE OHMMETER (R X 10 SCALE) | TB1-1 to TB1-2<br>TB1-3 to TB1-4 | 249 ± 1 PERCENT OHMS. |

Figure 6-59. Electronic components assembly (A6), test data

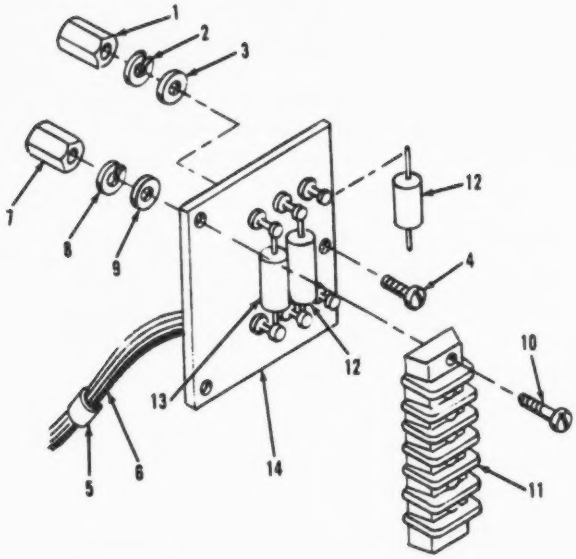


Figure 6-60. Electronic components assembly (A6), exploded view

Legend to figure 6-60:

1. Standoff
2. Lock washer
3. Washer
4. Screw
5. Cable strap
6. Wire
7. Standoff (2)
8. Lock washer (2)
9. Washer (2)
10. Screw (2)
11. Terminal board
12. Resistors, R4 and R5
13. Capacitor, C1
14. Terminal board assembly

a. Tag, then disconnect hook-up wire.

b. Exercise care not to apply excessive heat to components when unsoldering components.

6-201. CLEANING. Clean all components with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

6-202. INSPECTION.

a. Check electrical components for opens, shorts, continuity, and proper valves.

b. Inspect components for security.

c. Inspect wiring for defective insulation and continuity.

d. Inspect terminal board for cracks, warping, burned or discolored areas, and illegible stenciling.

6-203. REPAIR.

a. Repair or fabricate electronics components assembly hookup wire in accordance with table 6-21.

b. Restencil all illegible reference designations.

c. Replace all defective components.

d. After replacement of components, coat the terminal board with protective coating, conforming to Military Specification MIL-I-46058, grade S, type PUR, 0.005 minimum thickness. Air bubbles should be prevented during coating, so that legibility of identification or information markings are not impared. The coating shall be applied so that it anchors the components to the board. Terminals utilized for connection to external circuits shall not be coated.

Table 6-21. Electronics Components Assembly (A6), Hook Up Wire Data

| WIRE | WIRE LENGTH (INCHES) | FROM | TO |
|---|---|---|---|
| 1 | 3.50 | E4 | TB1-1 |
| 2 | 4.50 | E1 | TB1-2 |
| 3 | 3.50 | E5 | TB1-3 |
| 4 | 3.00 | E2 | TB1-4 |
| 5 | 2.00 | E3 | TB1-5 |
| 6 | 5.00 | E6 | TB1-6 |

NOTES

1. Solder using Federal Specification Q-Q-S-571, Sn 60.
2. Wire is in accordance with MIL-STD-454, requirement 20.

6-204. REASSEMBLY. Refer to figure 6-60 and reassemble the electronic components assembly in reverse order of index numbers assigned. Pay particular attention to the following.

a. Exercise care not to apply excessive heat to components when soldering connections.

b. Connect wires from components to terminal board according to table 6-21 and figure 1-15.

c. Test electronics components assembly in accordance with figure 6-59.

6-205. INSTALLATION. Refer to figure 6-21 and install the electronic components assembly in the precise relay box. Secure the relay in position with three screw assemblies. then refer to figure 1-15 and reconnect wiring. Replace precise relay box cover.

## 6-206. PRECISE RELAY BOX (A25).

## 6-207. TEST AND REMOVAL.

a. Symptom and Isolation of Malfunction. A malfunction of the precise relay box is usually indicated by a failure of the under frequency relay, under voltage relay, permissive paralleling relay, electronic components assembly, and unequal real load sharing when the generator set is operated in parallel. To isolate the malfunction, refer to figure 1-14 and proceed as follows.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside precise relay box with generator set operating.

NOTE

Remove cover from precise relay box to gain access to test points, see figures 6-49 and 6-50.

1. To isolate a malfunction of the under frequency relay, refer to paragraph 6-171.

2. To isolate a malfunction of the under voltage relay, refer to paragraph 6-180.

3. To isolate a malfunction of the permissive paralleling relay, refer to paragraph 6-189.

4. To isolate a malfunction of the electronic components assembly, refer to paragraph 6-198.

5. To isolate a malfunction in the real load sharing circuit, measure the resistance of rheostat R28 located in the precise relay box. Resistance should be adjustable in the range of 15K ohms ±10 percent.

b. Removal. Refer to figure 6-14, disconnect the two electrical plug connectors at the precise relay box receptacles, then remove the two screws and washers securing the box in position. Remove the precise relay box.

## 6-208. TEST.

a. Refer to table 6-22 and perform a continuity and resistance test of the precise relay box.

b. Connect the precise relay box to test equipment as illustrated in figure 6-61 and perform test specified in procedural analysis table 6-23.

6-209. DISASSEMBLY. Disassemble the precise relay box to the extent necessary to accomplish repair. Refer to figures 6-49 and 6-62 and disassemble in the order of index numbers assigned. Pay particular attention to the following.

NOTE

Remove the four screws and washers securing the cover to the relay chassis.

a. Tag, then disconnect harness wiring from components.

Table 6-22. Precise Relay Box (A25), Continuity and Resistance Test

| FROM | TO | REQUIRED RESULT |
|---|---|---|
| J32-S | J8-S | Continuity |
| J32-U | J8-U | Continuity |
| J32-M | J8-M | Continuity |
| J32-T | J8-T | 249 ohms |
| J32-N | J8-N | 249 ohms |
| J32-A | J8-A | Continuity |
| J32-B | J8-B | Continuity |
| J32-D | J8-D | Continuity |
| J32-C | J8-C | Continuity |
| J32-G | J8-G | Continuity |
| J32-J | J8-J | Continuity |
| J8-E | J8-F | 15K ohms |
| J8-E | J8-H | 0-15K ohms |
| J8-F | J8-H | 0-15K ohms |
| J8-K | J8-L | Continuity with switch S10 in 50 Hz position. |
| J8-R | J8-P | With ohmmeter set to RX 10,000 scale, meter should read 0 ohms and slowly rise to infinity. |

b. Remove under voltage relay (K11), under frequency relay (K12) and permissive paralleling relay (K16) from the chassis by removing their attaching screw assemblies (4 each).

NOTE

Refer to paragraphs 6-179, 6-170, and 6-188, respectively, for relay maintenance instructions.

c. Remove terminal board (TB3) and electronic components assembly (A6) and mounting bracket from the chassis as an assembly by removing two screw assemblies (35, figure 6-62).

d. Remove the three screw assemblies (10) securing the electronic components assembly (A6) to bracket (36).

NOTE

Refer to paragraph 6-197 for assembly maintenance.

e. Remove the wire harness from the chassis by removing eight screw assemblies and nuts.

6-210. CLEANING. Clean all components with a lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

6-211. TEST.

a. Harness.

1. Inspect harness wiring for defective insulation and continuity.

2. Inspect harness connectors for damaged threads; bent, loose or missing pins, and for shorts.

b. Test rheostat (R28) for full resistance value; 0-15 ohms ±10 percent.

c. Test switch (S10) for proper make and break operation.

Legend to Figure 6-61;

| REF DES | DESCRIPTION |
|---|---|
| A6 | Governor Resistor Assembly |
| A6C1 | Capacitor, Fixed |
| A6R4 | Resistor, Fixed |
| A6R5 | Resistor, Fixed |
| A6TB1 | Terminal Board |
| DS1 | Lamp, Indicating |
| DS2 | Lamp, Indicating |
| DS3 | Lamp, Indicating |
| FM | Meter, Frequency |
| J8 | Connector, Receptacle |
| J32 | Connector, Receptacle |
| K11 | Under Voltage Relay |
| K12 | Under Frequency Relay |
| K16 | Permissive PRL Relay |
| P32 | Connector, Plug |
| R28 | Resistor, Variable |
| S10 | Switch, Toggle |
| T1 | Autotransformer |
| TB3 | Terminal Board |
| VM No. 1 | Meter, Volt |
| VM No. 2 | Meter, Volt |
|  | Power Supply, 24VDC, 0.5 Amp |
|  | Power Supply, 0-130VAC, 45 to 65 Hz, 2 Amp |

Table 6-23. Precise Relay Box (A25) Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 1. | Energize DC power supply. | Indicator lights DS1 and DS2 should light. | Defective relays K11, K12, or K16. | Test relays in accordance with paragraphs 6-181 and 6-190. |
| 2. | Energize AC power supply. Adjust input for 120 ± 1 VAC, 60±1 Hz. Set switch S10 to 60 Hz position. | Indicator lights DS1 and DS2 should extinguish and DS3 should light. | Defective relays K11 and K12. | Test relays in accordance with paragraph 6-181. |
| 3. | Adjust T1 so that voltmeter VM2 reads 15-20 VAC. | Indicator light DS3 should extinguish. | Defective relay K16. | Test relay in accordance with paragraph 6-190. |
| 4. | Lower voltage (step 3 preceeding) below 10 VAC. | Indicator light DS3 should light. | Same as step 3. | Same as step 3. |
| 5. | Lower AC voltage to 99 VAC (read on voltmeter VM1). | Indicator light DS3 should extinguish and DS2 should light in approximately 6±2 seconds. | Defective relay K11. | Test relay in accordance with paragraph 6-181. |

Table 6-23. Precise Relay Box (A25) Procedural Analysis (Continued)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 6. | Reset voltage to 120 ± 1 volt AC. See Note 1 | Indicator light DS2 should extinguish and DS3 should light. | Same as step 5. | Same as step 5. |
| 7. | Lower frequency to 54 Hz. | Indicator light DS3 should extinguish and DS1 should light. | Defective relay K12. | Test relay in accordance with paragraph 6-181. |
| 8. | Reset frequency to 60±1 Hz. | Indicator light DS1 should extinguish and DS3 should light. | Same as step 7. | Same as step 7. |
| 9. | Set switch S10 to 50 Hz position and lower frequency to 45 Hz. | Indicator light DS3 should extinguish and DS1 should light. | Same as step 7. | Same as step 7. |
| 10. | Turn off power supplies. | | | |

NOTE: 1. Install a 100 Ω, 5 watt, resistor in parallel with R5, located on assembly (A26) in the precise relay box in order to lower frequency to 54 hertz.

d. Inspect terminal board (TB3) for cracks and missing hardware.

6-212. REPAIR.

a. Repair or fabricate precise relay box wire harness in accordance with figure 6-63.

b. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with a suitable abrasive paper and touch up painted surfaces. Restencil panel markings as necessary.

6-213. REASSEMBLY. Refer to figures 6-49 and 6-62 and reassemble the precise relay box in reverse order of index numbers assigned. Pay particular attention to the following.

a. Install wire harness (4) in chassis assembly (39) and secure in position with eight screw assemblies (2) and nuts (3).

b. Assemble electronic components assembly (11) and terminal board (34) to bracket (36), then install the assembly in chassis assembly (39).

c. Assemble under voltage relay (27), permissive paralleling relay (29), and underfrequency relay (31) in position using four each, screw assemblies.

d. Refer to figures 6-63 and 1-15 and connect wire harness leads to componentry.

NOTE

Solder connections shall be made using solder, Federal Specification QQ-S-571, Sn 60.

e. Test precise relay box as outlined in paragraph 6-208.

f. Secure cover (1) to chassis assembly (39), using four screws and washers.

6-214. INSTALLATION. Refer to figure 6-14 and install the precise relay box in position using two screws and washers. Reconnect electrical plug connectors to receptacles J8 and J32.

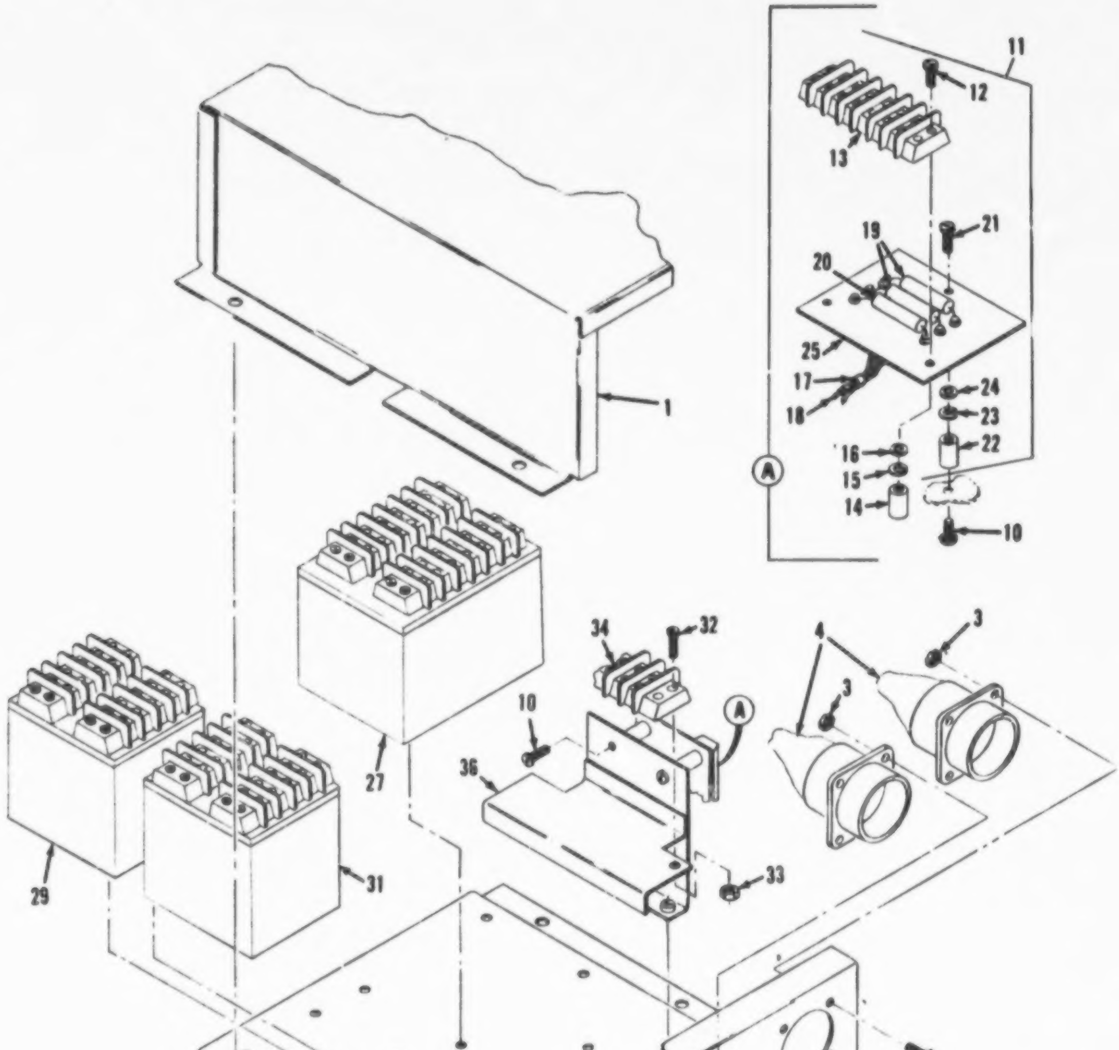

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Figure 6-62. Precise relay box (A25), exploded view

Legend to figure 6-62:

1. Cover
2. Screw assembly (8)
3. Nut assembly (8)
4. Wire harness
5. Nut
6. Toggle switch (S10)
7. Nut
8. Nut
9. Variable resistor (R28)
10. Screw assembly (3)
11. Electronic component assembly (A6)
12. Screw (2)
13. Terminal board (TB1)
14. Threaded standoff (2)
15. Lock washer (2)
16. Lock washer (2)
17. Cable strap
18. Wire
19. Resistor (R4, R5)
20. Capacitor (C1)
21. Screw
22. Threaded standoff
23. Lock washer
24. Washer
25. Terminal board assembly
26. Screw assembly (4)
27. Under voltage relay (K11)
28. Screw assembly (4)
29. Permissive paralleling relay (K16)
30. Screw assembly (4)
31. Under frequency relay (K12)
32. Screw assembly (2)
33. Nut assembly (2)
34. Terminal board (TB3)
35. Screw assembly (2)
36. Bracket
37. Rivet (4)
38. Identification plate
39. Chassis assembly

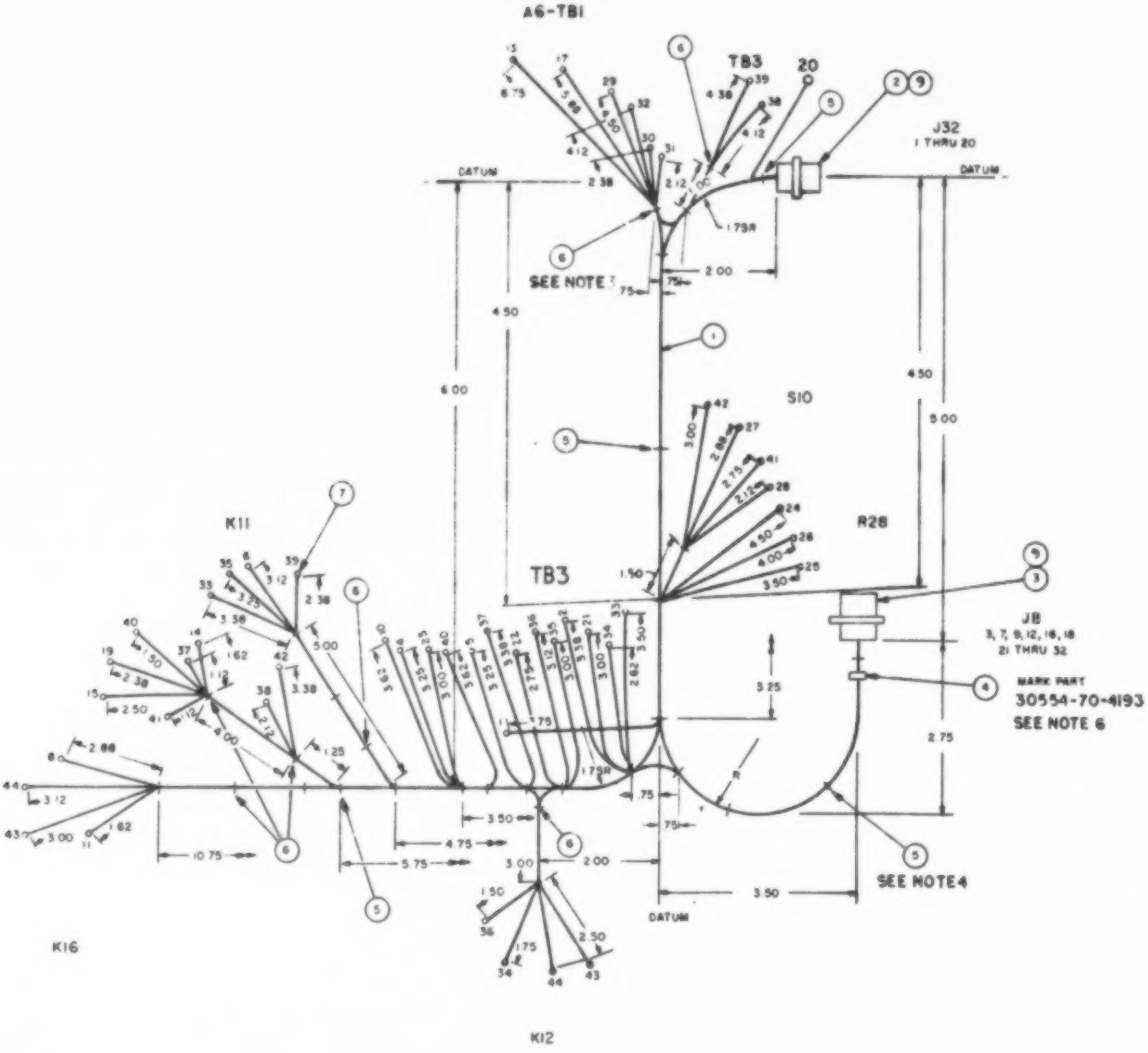
A6-TB1
TB3
20
J32
1 THRU 20
DATUM
DATUM
SEE NOTE 3
S10
R28
TB3
K11
J8
3, 7, 9, 12, 16, 18
21 THRU 32
MARK PART
30554-70-4193
SEE NOTE 6
SEE NOTE4
DATUM
K16
K12
1.75R
2.00
4.50
6.00
4.50
5.00
2.75
3.25
3.50
10.75
5.75
4.75
3.50
2.00
3.00
1.50
1.75
2.50
36
34
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Figure 6-63. Precise relay box (A25), wire harness
(sheet 1 of 2)

| WIRE NO. | WIRE MARKING IDENTIFICATION COLOR | WIRE MARKING IDENTIFICATION NUMBER | FROM | TERMN FIND NO | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| 1 | BLACK | X9M16 | J32-A | 2 | TB3-1 | 7 | 11.50 |
| 2 | BLACK | X12P16 | J32-B | ↑ | TB3-3 | 7 | 12.50 |
| 3 | BLACK | P81B16 | J32-C | | J8-C | 3 | 14.50 |
| 4 | BLACK | P55AD16 | J32-D | | TB3-6 | 7 | 14.25 |
| 5 | BLACK | P50N16 | J32-E | | TB3-5 | 7 | 13.50 |
| 6 | BLACK | P204D16 | J32-F | | K11-3 | 7 | 20.50 |
| 7 | BLACK | K110B16 | J32-G | | J8-G | 3 | 14.50 |
| 8 | BLACK | P57J16 | J32-H | | K11-7 | 7 | 21.00 |
| 9 | BLACK | K111B16 | J32-J | | J8-J | 3 | 14.50 |
| 10 | BLACK | P200E16 | J32-K | | TB3-7 | 7 | 14.75 |
| 11 | BLACK | P60E16 | J32-L | | K16-8 | 7 | 20.25 |
| 12 | BLACK | K32E16 | J32-M | | J8-M | 3 | 14.50 |
| 13 | BLACK | K33E16 | J32-N | | A6-TB1-2 | 7 | 9.25 |
| 14 | BLACK | L93F16 | J32-P | | K16-1 | 7 | 18.50 |
| 15 | BLACK | X15L16 | J32-R | | K16-2 | 7 | 19.75 |
| 16 | BLACK | K102J16 | J32-S | | J8-S | 3 | 14.50 |
| 17 | BLACK | K34E16 | J32-T | | A6-TB1-4 | 7 | 9.00 |
| 18 | BLACK | [illegible] | J32-U | | J8-U | 3 | 14.50 |
| 19 | BLACK | P210D16 | J32-V | ↓ | K12-5 | 7 | 19.25 |
| 20 | BLACK | [illegible] | J32-Z | 2 | GRD LUG | 7 | 5.50 |
| 21 | BLACK | X9N16 | J8-A | 3 | TB3-2 | 7 | 9.75 |
| 22 | BLACK | X12R16 | J8-B | 3 | TB3-4 | 7 | 10.75 |

| WIRE NO. | WIRE MARKING IDENTIFICATION COLOR | WIRE MARKING IDENTIFICATION NUMBER | FROM | TERMN FIND NO | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| 23 | BLACK | P55AF16 | J8-D | 3 | TB3-6 | 7 | 12.50 |
| 24 | BLACK | K105B16 | J8-E | ↑ | R28-3 | 7 | 11.75 |
| 25 | BLACK | K107B16 | J8-F | | R28-1 | 7 | 11.25 |
| 26 | BLACK | K106B16 | J8-H | | R28-2 | 7 | 12.25 |
| 27 | BLACK | K114B16 | J8-K | | S10-11 | 7 | 11.50 |
| 28 | BLACK | K115B16 | J8-L | | S10-12 | 7 | 11.25 |
| 29 | BLACK | K103B16 | J8-N | | A6-TB1-1 | 7 | 16.50 |
| 30 | BLACK | K108B16 | J8-P | | A6-TB1-5 | 7 | 15.00 |
| 31 | BLACK | K109B16 | J8-R | ↓ | A6-TB1-6 | 7 | 14.00 |
| 32 | BLACK | K104B16 | J8-T | 3 | A6-TB1-3 | 7 | 16.00 |
| 33 | BLACK | X9R16 | TB3-1 | 7 | K11-1 | 7 | 16.50 |
| 34 | BLACK | X9S16 | TB3-2 | 7 | K12-1 | 7 | 9.00 |
| 35 | BLACK | X12T16 | TB3-3 | 7 | K11-2 | 7 | 14.75 |
| 36 | BLACK | X12U16 | TB3-4 | 7 | K12-2 | 7 | 8.25 |
| 37 | BLACK | P50P16 | TB3-5 | 7 | K16-3 | 7 | 11.75 |
| 38 | BLACK | P55AE16 | TB3-6 | 7 | K16-4 | 7 | 20.75 |
| 39 | BLACK | P200F16 | TB3-7 | 7 | K11-4 | 7 | 23.50 |
| 40 | BLACK | P200H16 | TB3-7 | 7 | K12-6 | 7 | 11.25 |
| 41 | BLACK | K144A16 | K12-7 | 7 | S10-6 | 7 | 16.75 |
| 42 | BLACK | K145A16 | K12-8 | 7 | S10-5 | 7 | 16.75 |
| 43 | BLACK | P59A16 | K12-4 | 7 | K16-7 | 7 | 16.75 |
| 44 | BLACK | P71A16 | K12-3 | 7 | K11-8 | 7 | 17.50 |

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 9 | | | TYPE F, FORM U, GRADE a, CL 1 CATEGORY 1 | 32 | TUBING, INSULATION, .106 ID X .016 WALL X .62 LG | MIL-I-631 | |
| 8 | | | SN60WRAP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | |
| 7 | | | MS25036-106 | 50 | TERMINAL, LUG, CRIMP STYLE | | |
| 6 | | | MS3367-4-9 | 12 | STRAP, TIEDOWN | | NYLON |
| 5 | | | MS3367-1-9 | 13 | STRAP, TIEDOWN | | NYLON |
| 4 | | | MS39020-2 | 1 | BAND, MARKER | | AL ALY |
| 3 | | | MS3102R24-28S | 1 | CONNECTOR, RECEPTACLE | | |
| 2 | | | MS3102R24-28P | 1 | CONNECTOR, RECEPTACLE | | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 8, SOLDER CONNECTIONS PER MIL-STD-454, REQT 5.
3. CABLE STRAPS, FIND NO.5 AND 6, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, PARA 3.3.3 AND 3.3.3.1 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

Figure 6-63. Precise relay box (A25), wire harness (sheet 2 of 2)

## SECTION X

## ELECTRO-HYDRAULIC GOVERNING SYSTEM (CLASS I, PRECISE SETS ONLY)

### 6-215. General

a. The electro-hydraulic governing system is a speed (frequency) sensing system used to maintain prime mover speed constant and therefore generator output frequency, during periods of unchanging load and when load additions or deletions occur.

b. The system consists of a control unit, load measuring unit and hydraulic throttle actuating unit.

c. The control unit inputs are the generator output voltage, and a dc voltage (0-9.8 Vdc) proportional to the generator load, supplied by the load measuring unit. The generator voltage input is applied to a frequency sensing network and reference voltage network. The differential output of these two networks determines the control current of two magnetic amplifiers whose outputs drive separate coils of the hydraulic actuators pilot valve. The actuator pilot valve positions the actuator power piston which is connected to the input arm of the fuel injection pump. The actuators hydraulic system is comprised of a reservoir, engine driven pump 300-320 psi, (21.09 - 22.50 kg sq/cm), 2 gpm (7.57 liters/min), cooler and filter.

d. Any deviation of engine speed, reflected as a change in frequency at the input of the governor, produces a change in the magnitude and direction of magnetic amplifier control field current. This change in control field current will increase the strength of one coil of the pilot valve while decreasing the strength of the other. The resultant difference repositions the pilot valve in turn repositioning the power piston which changes the output of the fuel injection pump, changing engine speed and consequently restoring generator frequency to its nominal value.

e. The load measuring units (LMU) input to the governor control provides for automatic load sharing when two or more sets are operated in parallel. Each set is equipped with an LMU.

f. If the load added to the system is not equally divided, the LMU inputs to their respective governors will differ. The resulting difference acting through additional windings of each sets governor (which are all connected in parallel) will reposition each sets actuator power piston such that fuel flow in the more heavily loaded set is decreased while that of the lightly loaded set is increased. Since the power input of each prime mover has been readjusted, equal division of true power (Kw) occurs with no deviation in frequency of any set.

### 6-216. Malfunction.

The following procedures are to be performed in the generator set unless otherwise specified.

a. If the FL - NL or NL -FL transient exceeds 1-1/2 percent of rated speed and/or does not reestablish stable engine operating conditions within one second, realign the control unit in accordance with paragraph 6-69. Also follow this procedure if the engine speed hunts. If the set cannot be stabilized, check sockets A and B of plug P-21(refer to Operator and Organizational Maintenance Manual) for 24 Vdc (A is positive).

b. If the engine speed increases to above nominal operating speed, check sockets A and B of P-17 for 120 Vac. If it is missing, troubleshoot the generator set wiring. (Refer to Operator and Organizational Maintenance Manual). If it is present, check the resistance of the frequency adjusting circuit consisting of R4 (250 ohms) rheostat R1 frequency adjust (500 ohms) and R5 (250 ohms) fixed resistor. Refer to Operator and Organizational Maintenance Manual. Measure the total circuit resistance across N and T of harness plug P17. The circuit resistance should be 1000 ohms (5 percent tolerance). After testing for correct total resistance, test the operation of the frequency adjust rheostat by connecting an ohmmeter across pins M and T and revolving the frequency adjust rheostat through its entire travel. The resistance should vary from 750 ohms to 250 ohms. Repeat this procedure using the ohmmeter across pins M and N of the harness plug. If the problem persists, check sockets A and B of plug P-21 for 24 Vdc (A is positive).

c. If the engine speed remains below the nominal operating speed, adjust R1. If there is no improvement, check the resistance of the frequency adjust circuit. Disconnect P-17 and check the resistance of the frequency adjust circuit consisting of R4 (250 ohms) fixed resistor, R1 frequency adjust rheostat (500 ohms) and R5 (250 ohms, 5 percent) fixed resistor. Refer to Operator and Organizational Maintenance Manual. Measure the total circuit resistance across N and T of harness plug P17. The circuit resistance should be 1000 ohms (5 percent tolerance). After testing for correct total resistance, test the operation of the frequency adjust potentiometer by connecting an ohmmeter across pins M and T and revolving the frequency adjust potentiometer through its entire travel. The resistance should vary from 750 ohms to 250 ohms. Repeat this procedure using the ohmmeter across pins M and N of the harness plug. Disconnect actuator electrical connector before making this measurement. Push actuator piston all the way down and adjust engine speed with manual throttle. If this value resistance is measured, check sockets A and B at plug P-21 for 24 Vdc (A is positive).

d. If the set is operating at a constant load and voltage and during an eight-hour period the change in ambient temperature does not exceed 60°F (15.6°C), the set frequency should not drift beyond 1/2 of one percent of rated frequency. The above requirement assumes that the set temperatures were stabilized at the initial and final ambient temperatures.

NOTE

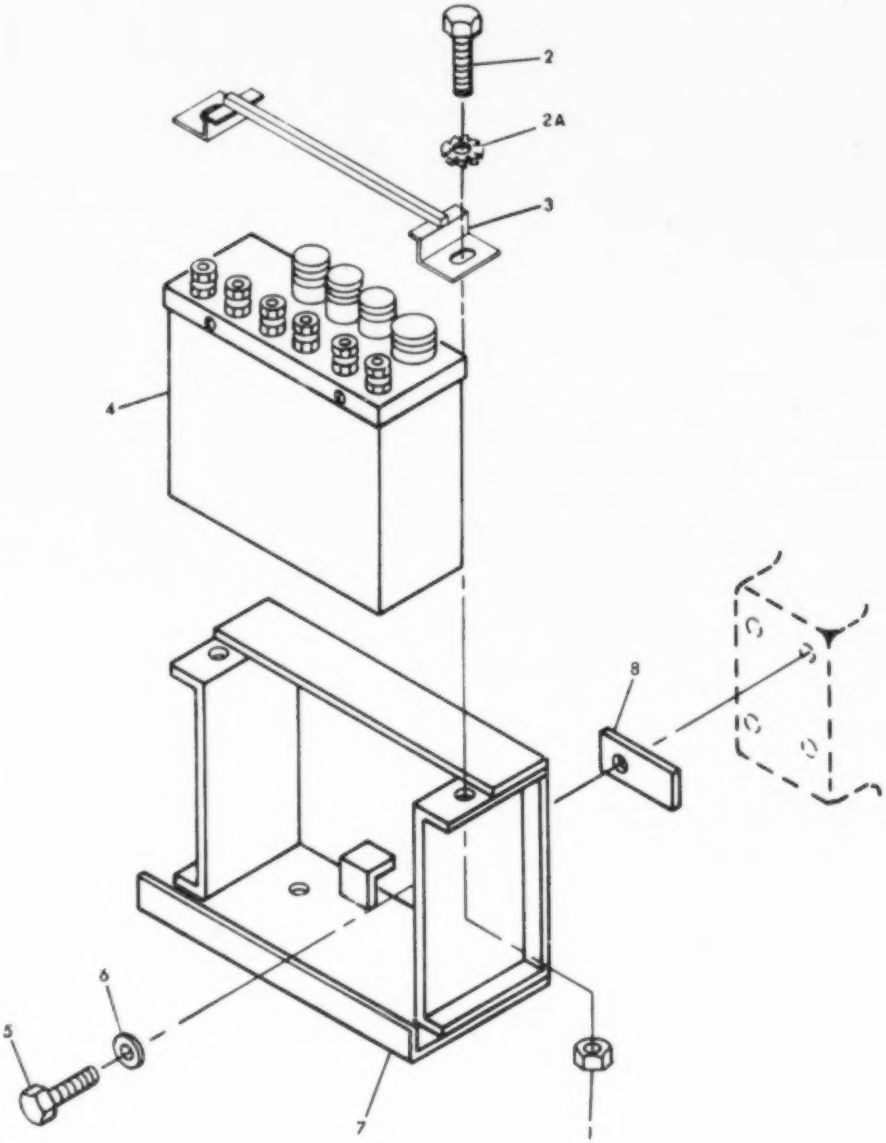
If the drift in paragraph d is excessive, realign the control unit following the procedure outlined in paragraph 6-221.

e. At constant ambient temperature, constant load, constant voltage and constant barometric pressure, the set frequency should remain within a bandwidth of 1 percent of rated frequency for a period of 4 hours. If this bandwidth has been exceeded, realign the control unit in accordance with paragraph 6-221.

f. If the preceding solutions to the specific problem do not resolve the problems, replace and repair the control unit, actuator (para 13-3 thru 13-8) or load measuring unit (para 8-15 thru 8-19) as required.

6-217. Removal.

Refer to figure 6-64 and remove in the order of sequence numbers.



1. Nut
2. Screw
2A. Washer
3. Holddown
4. Control unit
5. Screw
6. Washer
7. Bracket
8. Bracket

Figure 6-64. Electric Governor Control Unit Removal

6-218. Disassembly and Repair

a. Disassemble electric governor control unit, if required, as illustrated in figure 6-65.

NOTE

Disassembly and repair of electric governor control unit at the field level is restricted to removal of the cover, connectors, potentiometers and test jacks. Further disassembly requires unpotting and the following disassembly can be performed by depot maintenance personnel only.

b. Remove cover and components installed on cover in the order of sequence numbers (1 thru 15).

NOTE

Tag and unsolder wires for the components on the cover.

(1) Replace defective test jacks, potentiometers or connectors.

(2) Repair procedures for individual wires of a wiring harness are covered in the Operator and Organizational Maintenance Manual.

c. Remove six screws and lockwashers from cover of control unit. Lift cover slightly and set at a slight angle to keep the connectors and potentiometers out of the potting compound.

d. Place the complete unit in a temperature controlled oven, large enough to allow air to circulate completely around the unit.

CAUTION

The melting temperature of the potting compound is 165°F (74°C). The flash point is 515°F (268°C). Do not unpot by placing unit on a hot plate type surface or by using an open flame.

e. Set the oven temperature at 180°F (82°C) to 185°F (85°C) and allow the unit to soak until the potting compound is melted. The normal soak period at this temperature is 11 to 12 hours.

WARNING

Use care when handling the hot potting compound. It can cause severe injury to personnel.

f. Using heavy gloves and wearing safety glasses, remove the printed circuit board from the melted potting compound. Lift the board slowly, allowing the potting compound to drain off the components.

g. Set the printed circuit board with transformers on the bottom on a drain board and allow it to cool to room temperature.

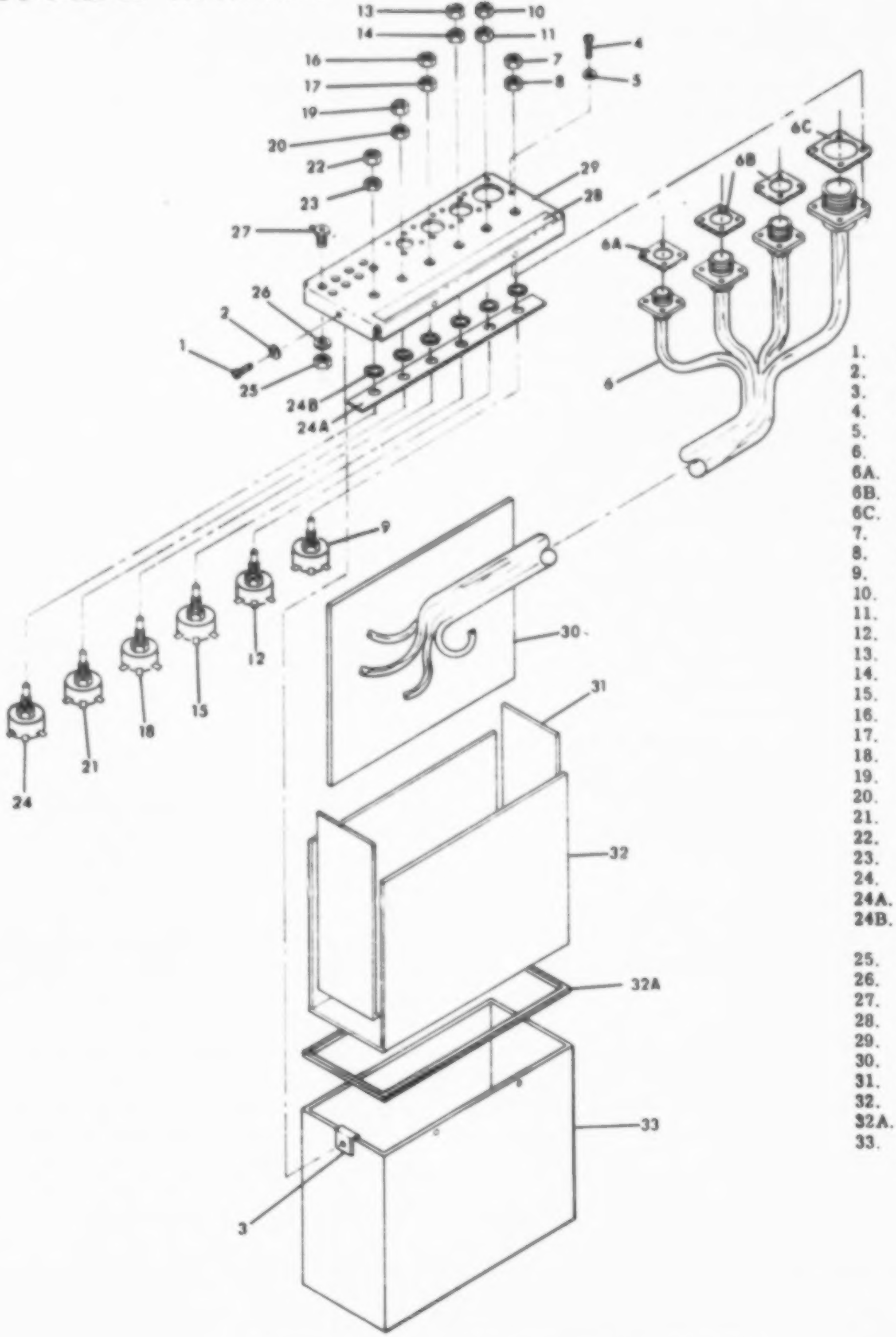
h. Remove screw (4) and lockwashers (5) which attach connectors (P1, J3, P5, P2) to cover.

i. Tag wiring and remove harness (6).

j. Disassemble remaining components mounted on cover in accordance with index numbers 7 through 27.

6-219. Cleaning and Inspection.

a. Clean all parts with a cloth dampened in cleaning solvent Federal Specification P-D-680 and dry thoroughly.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29
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6C
6B
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24B
24A
6
9
30
12
15
18
21
24
31
32
32A
33
3

| | |
|---|---|
| 1. | Screw |
| 2. | Washer |
| 3. | Nut, clip |
| 4. | Screw |
| 5. | Washer |
| 6. | Harness |
| 6A. | Gasket |
| 6B. | Gasket |
| 6C. | Gasket |
| 7. | Nut |
| 8. | Nut |
| 9. | Potentiometer |
| 10. | Nut |
| 11. | Nut |
| 12. | Potentiometer |
| 13. | Nut |
| 14. | Nut |
| 15. | Potention |
| 16. | Nut |
| 17. | Nut |
| 18. | Potentiometer |
| 19. | Nut |
| 20. | Nut |
| 21. | Potentiometer |
| 22. | Nut |
| 23. | Nut |
| 24. | Potentiometer |
| 24A. | Spacer |
| 24B. | Washer, Sealing |
| 25. | Nut |
| 26. | Washer |
| 27. | Testjack |
| 28. | Nameplate |
| 29. | Panel |
| 30. | Circuit Board |
| 31. | Insulation |
| 32. | Insulation |
| 32A. | Gasket |
| 33. | Cabinet |

Figure 6-65. Electric Governor Control Unit

b. Inspect for cracks, breaks, damaged connectors, damaged terminals, defective wiring, and defective components. Check potentiometer for continuity, resistance, and wiring for open insulation.

6-220. Tests and Repair.

a. Perform test as outlined in figures 6-66 thru 6-72.

NOTE

Mount circuit card as shown in figure 6-70 prior to test.

b. Resistance Test (50/60 Hz). Refer to Table 6-24 and perform resistance test.

c. See figure 1-4 and 1-5 for schematic diagrams.

d. See table 6-25 for values of individual components. When measuring individual components, disconnect at least one lead to prevent feedback readings.

e. Magnetic Amplifier Bias Test (50/60 Hz). Refer to figure 6-66 and perform the magnetic amplifier bias test.

f. Frequency Sensing Check, High and Low Frequency (50/60 Hz). Refer to figure 6-67 and perform the frequency sensing check.

g. Rectifier Bridge, CR7 thru CR10 and Feedback Winding Test (50/60 Hz). Refer to figure 6-68 and perform the rectifier bridge and feedback winding test.

h. Parallel Winding Test (50/60 Hz). Refer to figure 6-69 and perform the parallel winding test.

i. Replace any component found to be defective during tests.

j. For wiring harness repairs, refer to Operator and Organizational Maintenance Manual.

k. If wiring harness has sustained extensive damage, refer to figure 6-73 for wiring harness rebuilding procedures.

6-221. Assembly.

a. See figure 6-71 and assemble printed circuit board. If any connections are opened or bared for test purposes, or if any defective components are replaced, the effected area and components must be coated with polyurethane resin to prevent oxidation or other corrosion. The coating must be of a minimum thickness of 0.007 inches (.1778 mm) and air bubble entry into the applied polyurethane must be controlled so that the legibility of component coding and identification is not impaired. The polyurethane resin to be utilized will correspond to MIL-I-46058, Grade S, Type PUR.

b. See figure 6-65 and reassemble control unit components.

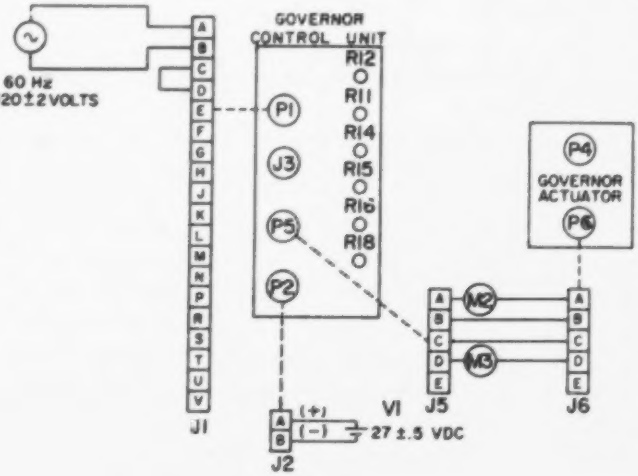
c. Reconnect cover to printed circuit board with wiring harness.

d. Place the container in a temperature controlled oven. Set oven temperature at 180° to 185°F (82.2 to 85.0°C) and allow container to soak 11 to 12 hours or until potting compound is completely melted.

e. Prior to installing the printed circuit board, remove the container from the oven and make sure that insulation paper is positioned next to the container shell.

Table 6-24. Resistance Test (50/60 Hz)

| P1 Connection | Potentiometer Position | Nominal Resistance | Allowance resistance range (ohms) |
|---|---|---|---|
| T-N (T +) | | 5100 | 3400-6800 |
| M-N (M +) | | 2180 | 1950-2400 |
| (M +) | R18CCW | 12180 | 11000-13000 |
| F-N (F +) | | 6000 | 5000-7000 |
| (F +) | R16CCW | 31000 | 30000-32000 |
| (F +) | R15CCW | 6500 | 5500-7500 |
| E-G (E +) | | 5500 | 4500-6500 |
| R-G (R +) | | 120 | 100-140 |
| F-G (F + ) | | 650 | 550-750 |
| J-H (J +) | | LESS THAN 0.2 OHMS | |
| T-P (T +) | | 2200 | 1400-3000 |
| (T +) | R14CCW | 2600 | 1800-3400 |
| U-S (U + ) | | 525 | 450-600 |
| USING M1, MEASURE RESISTANCE OF EACH PIN (ALL CONNECTORS) AND EACH TEST POINT TO GOVERNOR CONTAINER. RESISTANCE SHOULD BE INFINITY ON 100,000 OHM SCALE. REPEAT FOR REVERSE POLARITY. RESISTANCE SHOULD BE INFINITY ON 100,000 OHM SCALE. | | | |


60 Hz
120±2 VOLTS
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
T
U
V
J1
GOVERNOR CONTROL UNIT
P1
J3
P5
P2
R12
R11
R14
R15
R16
R18
(+)
(-)
A
B
J2
V1
27 ±.5 VDC
A
B
C
D
E
J5
M2
M3
P4
GOVERNOR ACTUATOR
P6
A
B
C
D
E
J6

MAGNETIC AMPLIFIER BIAS TEST

TURN R11, R12, R14, R15, R16, R18 FULL CW.

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN.

ADJUST R11 AND R12 FOR BALANCED READING OF 450 MA ON M2 AND M3.

TURN R12 FULL CW. M2 AND M3 SHALL READ 0-300 MA, AND BE BALANCED WITHIN 50 MA.

TURN R12 FULL CCW. M2 AND M3 SHALL READ 600-1000 MA, AND BE BALANCED WITHIN 50 MA.

READJUST R11 AND R12 FOR BALANCED READING OF 450 MA ON M2 AND M3. LOCK R11 AND R12 FOR REMAINDER OF TEST.

Figure 6-66. Electric Governor Control Unit, Magnetic Amplifier Bias Test (50/60 Hz)

Table 6-25. Electric Governor Control Unit Component Values

| Component | 50/60 Hz Unit (ohms) | Remarks |
|---|---|---|
| R1, R1A, R15 | 500 | 3.0% tolerance |
| R11 | 5000 | |
| R4, R8, R22 | 5100 | 3.0% tolerance |
| R37 | 5100 | |
| R2, R10 | 1250 | 3.0% tolerance |
| R12, R18 | 10,000 | 3.0% tolerance |
| R16 | 25,000 | 3.0% tolerance |
| R14, R20 | 3,000 | 3.0% tolerance |
| Parallel winding | Less than 1.0 (nominal) | Check for open |
| Feedback winding | Less than 1.0 (nominal) | Check for open |
| Frequency control winding | Less than 1.0 (nominal) | Check for open |
| Bias control winding | Less than 1.0 (nominal) | Check for open |

f. Using heat gloves and safety glasses slowly lower [illegible] board into the potting compound.

WARNING

Use care not to splash hot potting compound on operating personnel. It can cause severe injury.

g. Position the printed circuit board and allow compound to cool.

h. When compound has cooled and is substantially solid, install top cover and hardware.

6-222. Adjustment.

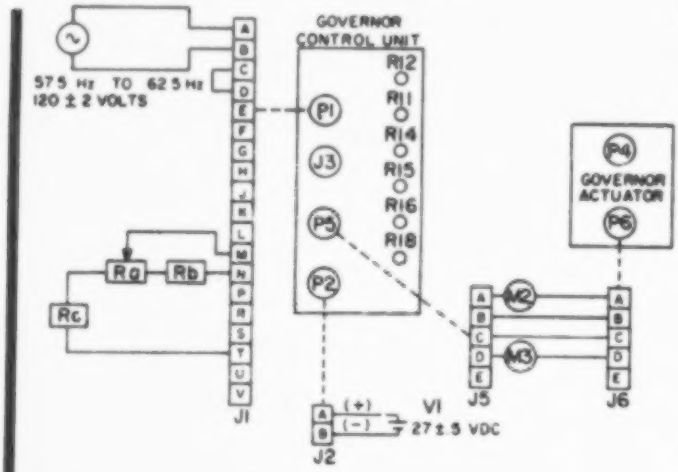
See figure 6-72 for location of adjustment and controls and adjust electric governor according to the following procedures:

a. Isochronous Operation

(1) With engine not operating, set frequency adjust control (on control panel), R11, R14, R16, and R18 to midpoint by turning full each way and approximating center. Set R15 full counterclockwise and R12 approximately 1/4 clockwise.

(2) Start engine. Refer to Operator and Organizational Maintenance Manual for operating instructions. If engine hunts, perform following adjustments to stabilize operation:

(a) If hunt is of high frequency and small amplitude, adjust R12 clockwise and/or R16 counterclockwise.



FREQUENCY SENSING CHECK (HIGH AND LOW FREQUENCY)

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN

TURN Ra SO THE RESISTANCE BETWEEN P1-M AND P1-T IS 250 OHMS.

REDUCE THE FREQUENCY OF THE APPLIED 120 ± 2 VOLT SUPPLY UNTIL M2 AND M3 BALANCE.

THE FREQUENCY SHALL BE 57 - 58 Hz.

TURN Ra SO THE RESISTANCE BETWEEN P1-M AND P1-N IS 250 OHMS.

INCREASE THE FREQUENCY OF THE APPLIED 120 ± 2 VOLT SUPPLY UNTIL M2 AND M3 BALANCE.

THE FREQUENCY SHALL BE 64 - 65 Hz.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Ra | 1 | POTENTIOMETER, 10 TURN, 500 OHM, 5 WATT |
| Rb, Rc | 2 | RESISTOR, FIXED, 250 OHM, 5 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| V1 | 1 | DC POWER SOURCE |
| ⏦ | 1 | AC POWER SOURCE |

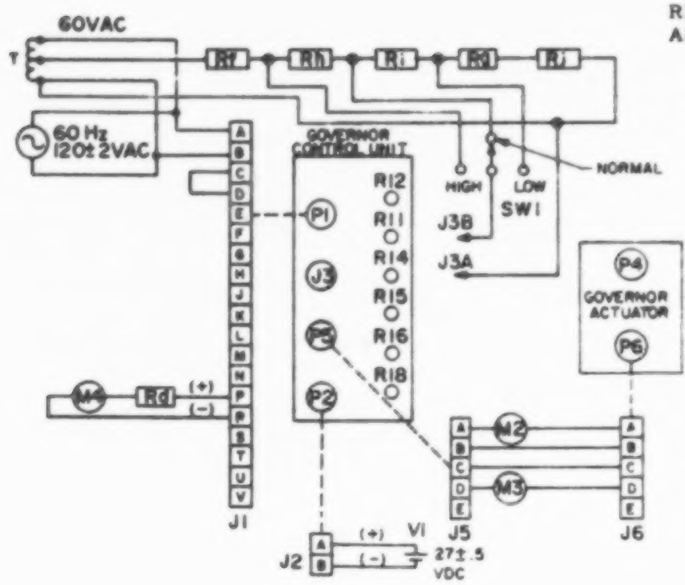
Figure 6-67. Electric Governor Control Unit, Frequency Sensing Check (High and Low Frequency) (50/60 Hz)

(b) If hunt is of low frequency and long amplitude, adjust R18 counterclockwise. If operation does not stabilize, turn R16 clockwise. It may be necessary to adjust R12 counterclockwise in conjunction with R18 and R16 adjustments to stabilize operation.

(3) Once the set has been stabilized, connect a 0 - 10 volt range dc voltmeter (high impedance type - 2000 ohms per volt or more) across test points 3 and 4 with the positive lead at test point 4. Adjust FREQUENCY ADJUST control to obtain operating frequency (400 Hz, or 60 Hz), and then adjust R14 until voltage across test points 3 and 4 is zero volts with no load on generator.

(4) Connect dc voltmeter across tests points 1 and 2 with positive lead at test point 1. Adjust R11 and the frequency adjust control until the dc voltmeter reads zero volts at nominal frequency. Repeat the adjustment until the voltage across test points 3 and 4 and across 1 and 2 is zero volts, and the set frequency is 50 Hz, 60 Hz or 400 Hz with no load on the engine. If test points 1 and 2 cannot be zeroed, they must be reduced to a minimum.

(5) Adjust R12 until a reading of approximately 4.5 volts is obtained across test points A and B, with no load on generator. If this voltage is too low, response will be sluggish and if it is too high, a rapid oscillation may occur. Normal range is 3 to 6 volts.



RECTIFIER BRIDGE, CR7 THRU CR10 AND FEEDBACK WINDING TEST.

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN

TURN R14 CCW, R15 CCW.

M4 SHOULD READ -5 TO -7MA.

ADJUST R14 CW TO BALANCE M2 AND M3.

TURN SW1 TO "LOW"
M2 SHALL READ 600-840MA.
M3 SHALL READ 0-300 MA.
M4 SHALL READ 0 TO +1.5 MA.

TURN SW1 TO "HIGH"
M2 SHALL READ 0-300 MA.
M3 SHALL READ 600-840 MA.
M4 SHALL READ 0 TO -1.5 MA.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Rd | 1 | RESISTOR, FIXED, 5000 OHMS, 1 WATT |
| Rf, Rg | 2 | RESISTOR, FIXED, B2 OHM, 10 WATT |
| Rh, Ri | 2 | RESISTOR FIXED, 15 OHMS, 5 WATT |
| Rj | 1 | RESISTOR, FIXED, 25 OHMS, 5 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| M4 | 1 | MILLIAMMETER, DC, ZERO CENTER, 10-0-10 MA |
| Swl | 1 | SWITCH, ROTARY, 3 POSITION, 1 POLE, 1 AMP |
| V1 | 1 | DC POWER SOURCE |
| ~ | 1 | AC POWER SOURCE |
| T | 1 | AUTOTRANSFORMER 2:1 RATIO |

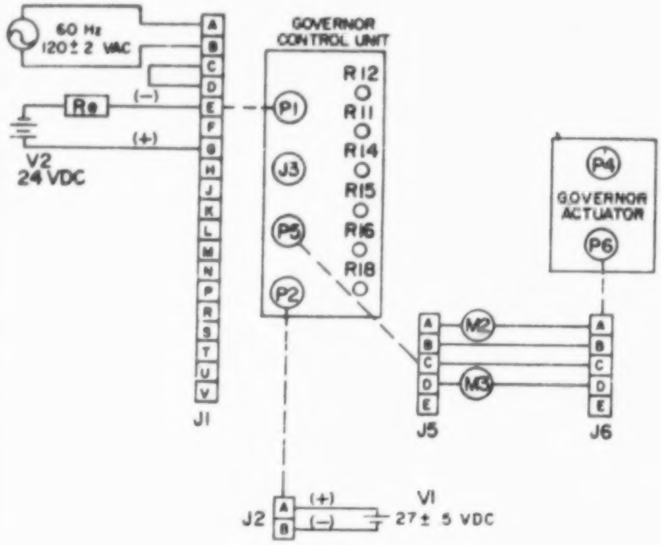
Figure 6-68. Electric Governor Control Unit, Rectifier Bridge and Feedback Winding Test (50/60 Hz)

(6) Adjust R18 clockwise as far as possible, and R16 counterclockwise as far as possible without causing oscillation.

NOTE

Increasing the load measurement gain R15 (turning in a clockwise direction) will improve transient performance; therefore, it should be adjusted as high as possible. Transient performance must be checked using a frequency recorder.

(7) The adjustment of R18 and R16 are interdependent. For any position of R18 there is an optimum position for R16. Therefore, to improve transient performance increase the frequency gain by turning R18 clockwise. If hunt develops, readjust R16 for stability. If no hunt develops, apply and reject load on the generator set to check for stability under transient conditions. Assuming that no hunt develops for an increase in frequency gain, (R18 turned clockwise) or that hunt can be removed by readjustment


60 Hz
120 ± 2 VAC
GOVERNOR CONTROL UNIT
Re
(−)
(+)
V2
24 VDC
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
T
U
V
J1
P1
J3
P5
P2
R12
R11
R14
R15
R16
R18
P4
GOVERNOR ACTUATOR
P6
M2
M3
J5
J6
J2
(+)
(−)
V1
27 ± 5 VDC

PARALLEL WINDING TEST

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN.

M2 SHALL READ 0-300 MA.
M3 SHALL READ 600-840 MA.

REVERSE POLARITY OF CONNECTIONS TO PINS J1-E AND J1-G.

M2 SHALL READ 600-840 MA.
M3 SHALL READ 0-300 MA.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Re | 1 | RESISTOR, FIXED, 50,000 OHMS, 10 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| V1 | 1 | DC POWER SOURCE |
| V2 | 1 | DC POWER SOURCE |
| ∿ | 1 | AC POWER SOURCE |

Figure 6-69. Electric Governor Control Unit Parallel Winding Test (50/60 Hz)

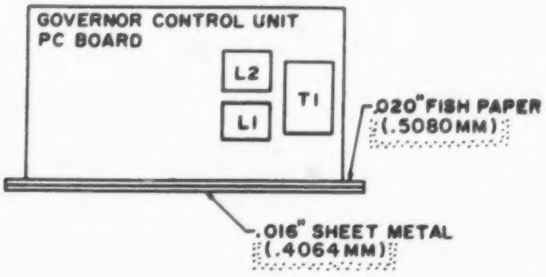

GOVERNOR CONTROL UNIT
PC BOARD
L2
L1
T1
.020" FISH PAPER
(.5080MM)
.016" SHEET METAL
(.4064MM)

Figure 6-70. Electric Governor Control Unit, Test Position for Unpotted Units

of R16, again increase frequency gain by turning R18 clockwise and note the transient performance. Finally a position may be reached where no readjustment of R16 can stabilize for the high frequency gain of R18. Then reduce the frequency gain to the stable region and optimize stability and performance with R16. The frequency gain should be reduced to a point where the system is not on the edge of instability for long-term stable operation.

(8) Transient performance improves as the frequency gain R18 is increased and the feedback gain R16 is a minimum for that particular position of frequency gain adjustment. If R16 is adjusted too far counterclockwise, there will be insufficient feedback to stabilize the operation at steady state. If a slow oscillation occurs, turn R16 clockwise until stability is reached. This is the optimum setting for the level of frequency gain.

(9) If R16 is turned far clockwise, a very fast oscillation may occur. Turn R16 counterclockwise to the optimum point of stability.

b. Parallel Operation (Class 1 sets)

(1) Adjust in accordance with paragraph 16-11.

(2) If the sets will not divide load, or if they oscillate (successively interchange load) on the first attempt to parallel, check the polarity across pin A and B of the parallel receptacle on both sets and verify, that the input circuits to pin C and D are correct and that the voltages are as specified.

### 6-223. Equipment Test

If the electric governor control has been renewed or repaired, refer to Chapter 16, Section II and conduct the following tests.

a. Frequency and voltage regulation, stability and transient response test, short term. (para 16-15)

b. Frequency adjustment range test (para 16-16)

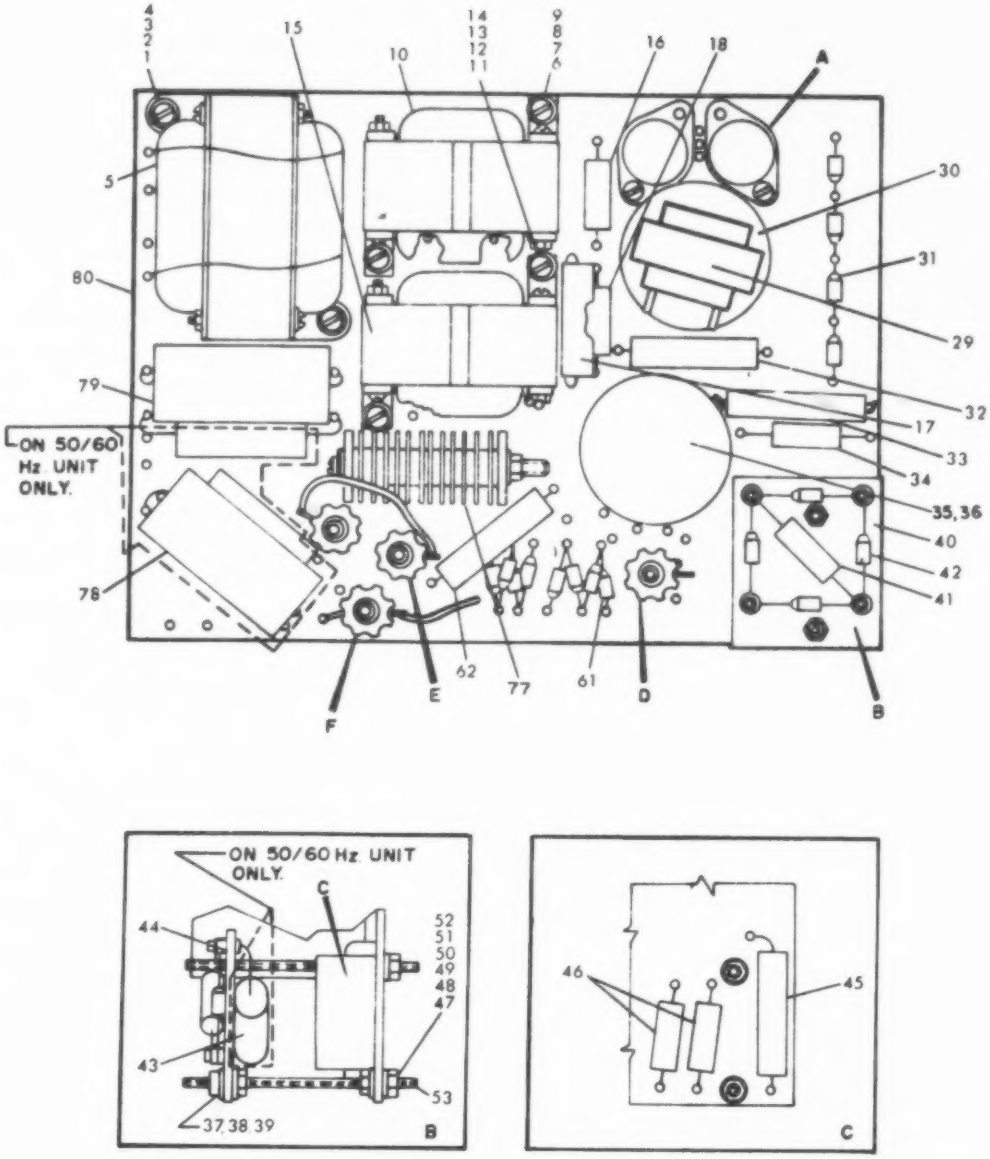

4
3
2
1
15
10
14
13
12
11
9
8
7
6
16
18
A
5
30
31
80
29
79
32
17
33
ON 50/60 Hz UNIT ONLY
34
35,36
40
42
41
78
62
77
61
D
E
F
B
ON 50/60 Hz. UNIT ONLY
C
44
52
51
50
49
48
47
43
53
37,38,39
B
46
45
C

Figure 6-71. Electric Governor Wiring Board Assembly (Sheet 1 of 2)

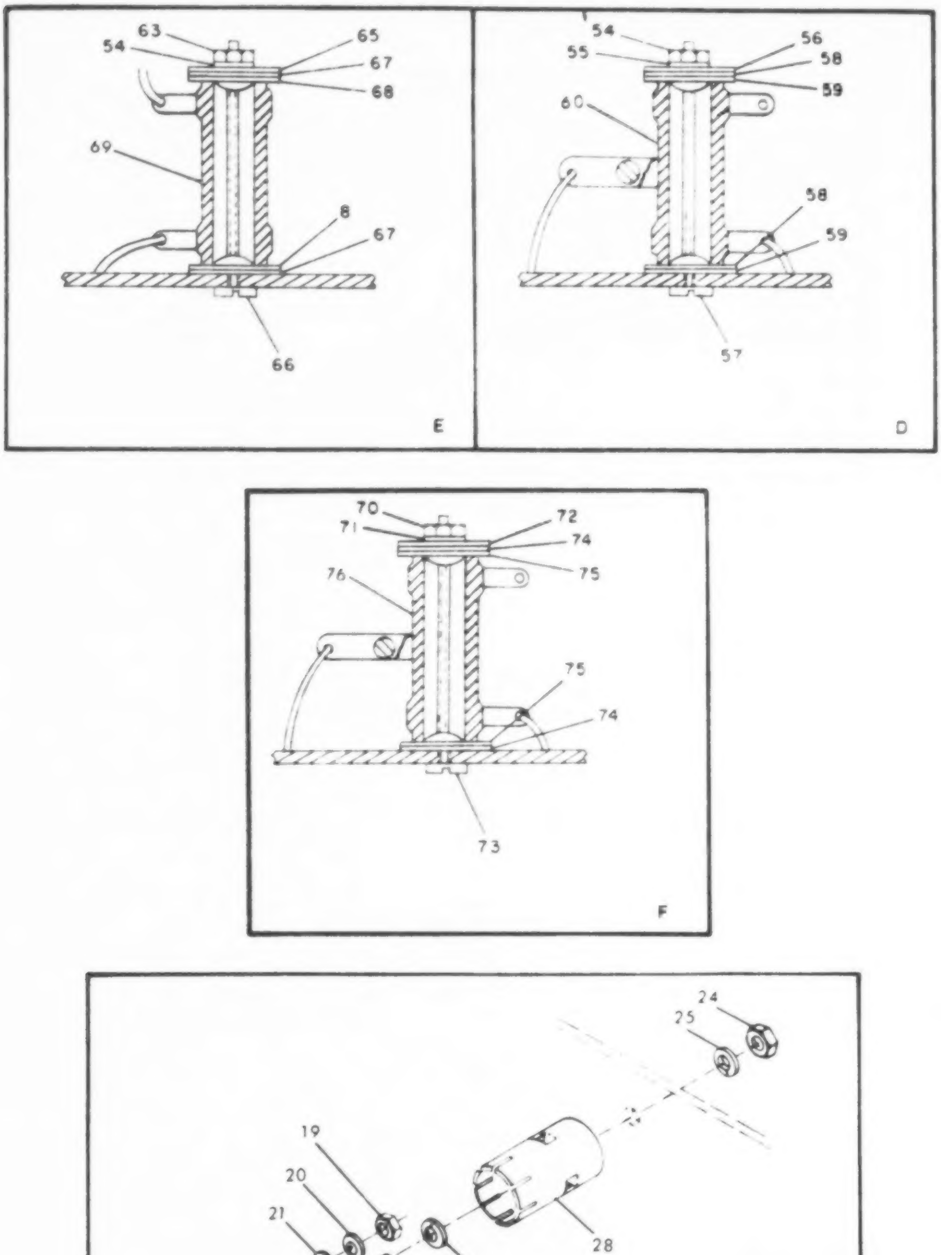

63
54
65
67
68
69
8
67
66
E
54
55
56
58
59
60
58
59
57
D
70
71
72
74
75
76
75
74
73
F
24
25
19
20
21
28
27
26
22
23
A

Figure 6-71. Electric Governor Wiring Board Assembly (Sheet 2 of 2)

KEY to figure 6-71

1. Nut (2)
2. Lock washer (2)
3. Flat washer (2)
4. Screw
5. Transformer (T1)
6. Nut (2)
7. Washer (2)
8. Washer (2)
9. Screw
10. Reactor (L1)
11. Nut (2)
12. Washer (2)
13. Washer (2)
14. Screw (2)
15. Reactor (22) (L2)
16. Resistor (R5)
17. Capacitor (C7)
18. Resistor (R23)
19. Nut (2)
20. Washer (2)
21. Washer (2)
22. Screws (2)
23. Transistor (Q1 & Q2)
24. Nut (2)
25. Washer (2)
26. Screw (2)
27. Washer (2)
28. Heat sink (2)
29. Reactor (L3)
30. Transformer (T2)
31. Rectifiers (CR3, CR4, CR5, CR6)
32. Capacitor (C9)
33. Resistor (R20)
34. Resistor (R22)
35. Nut (1)
36. Mag amp (AR1)
37. Nut (2)
38. Washer (2)
39. Washer (2)
40. Board assy
41. Resistor (R37)
42. Rectifiers (CR7, CR8, CR9, CR10)
43. Capacitor(C2)
44. Board
45. Capacitor (C5)
46. Resistor (R4, R8)
47. Nut (2)
48. Washer (2)
49. Washer (2)
50. Washer (2)
51. Washer (2)
52. Nut (2)
53. Studs (2)
54. Nut (1)
55. Washer (1)
56. Flat washer (1)
57. Screw (1)
58. Washer (2)
59. Washer (2)
60. Resistor (R10)
61. Rectifiers (8)
62. Capacitor (C6)
63. Nut (2)
64. Washer (2)
65. Washer (2)
66. Screw (2)
67. Washer (4)
68. Washer (4)
69. Resistor (1 & R1 A)
70. Nut (1)
71. Washer (1)
72. Washer (1)
73. Screw (1)
74. Washer (2)
75. Washer (2)
76. Resistor (R2)
77. Rectifier (CR2)
78. Capacitor (C4)
79. Capacitor (C3)
80. Board

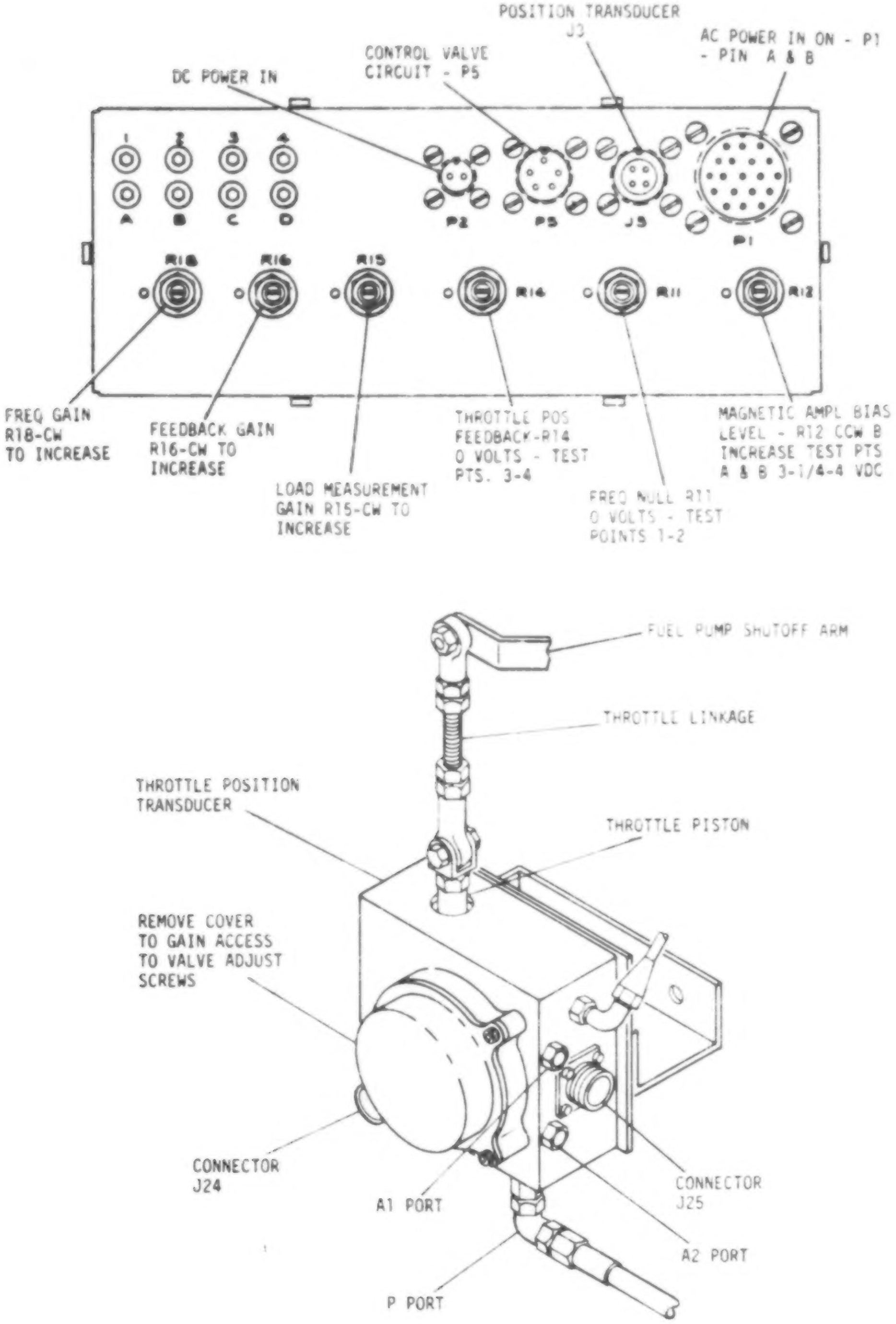

POSITION TRANSDUCER J3
AC POWER IN ON - P1 - PIN A & B
CONTROL VALVE CIRCUIT - P5
DC POWER IN
1
2
3
4
A
B
C
D
P2
P5
J3
P1
R18
R16
R15
R14
R11
R12
FREQ GAIN R18-CW TO INCREASE
FEEDBACK GAIN R16-CW TO INCREASE
LOAD MEASUREMENT GAIN R15-CW TO INCREASE
THROTTLE POS FEEDBACK-R14 0 VOLTS - TEST PTS. 3-4
FREQ NULL R11 0 VOLTS - TEST POINTS 1-2
MAGNETIC AMPL BIAS LEVEL - R12 CCW B INCREASE TEST PTS A & B 3-1/4-4 VDC
FUEL PUMP SHUTOFF ARM
THROTTLE LINKAGE
THROTTLE POSITION TRANSDUCER
THROTTLE PISTON
REMOVE COVER TO GAIN ACCESS TO VALVE ADJUST SCREWS
CONNECTOR J24
A1 PORT
CONNECTOR J25
A2 PORT
P PORT

Figure 6-72. Electric Governor Control Unit, Location of Adjustments and Controls

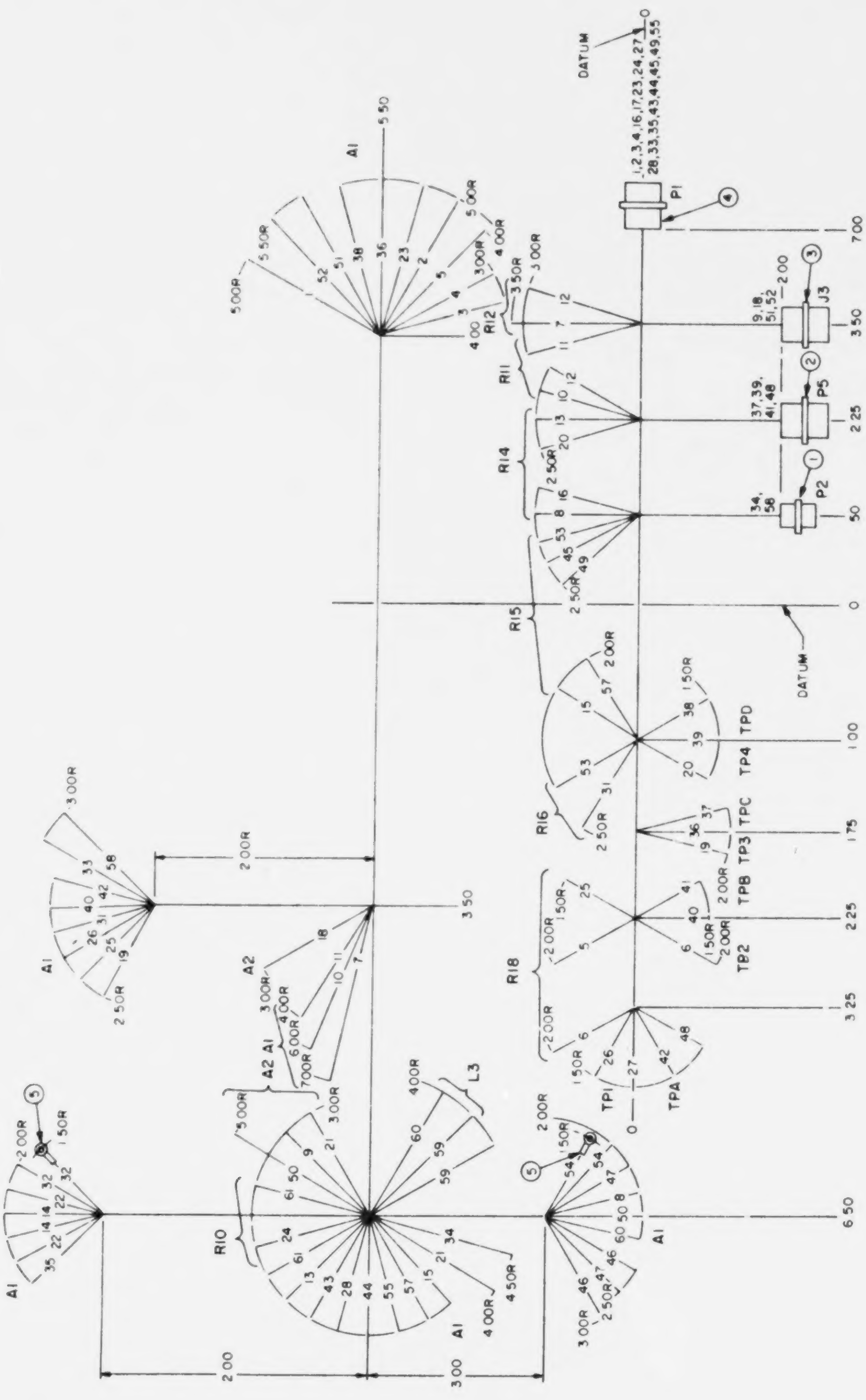

DATUM
1,2,3,4,16,17,23,24,27
28,33,35,43,44,45,49,55
0
P1
4
700
J3
3
9,18,
51,52
200
350
P5
2
37,39,
41,48
225
P2
1
34,
58
50
0
DATUM
TPD
TP4
100
TPC
TP3
175
TPB
TB2
225
325
TP1
TPA
0
650
A1
550
500R
550R
500R
400R
300R
350R
400
R12
R11
R14
R15
R16
R18
R10
A1
A2
A2 A1
L3
350
200R
200
300
5
150R
250R
300R
400R
450R
600R
700R
200R

Figure 6-73. Precise governor control unit (A23), wiring harness diagram (sheet 1 of 2)

| WIRE NO. (REF) | TERMINATION | | WIRE FIND NO. | WIRE CUT LENGTH (REF) |
|---|---|---|---|---|
| | FROM | TO | | |
| 1 | P1-B | A1-1 | 6 | 22.00 |
| 2 | P1-A | A1-2 | 6 | 22.00 |
| 3 | P1-K | A1-3 | 6 | 20.00 |
| 4 | P1-L | A1-4 | 6 | 20.00 |
| 5 | R18-2 | A1-5 | 6 | 18.50 |
| 6 | TP2 | R18-1 | 6 | 6.00 |
| 7 | R12-3 | A1-7 | 6 | 24.00 |
| 8 | R14-1 | A1-8 | 6 | 20.50 |
| 9 | J3-A | A2-B | 6 | 21.50 |
| 10 | R11-1 | A1-10 | 6 | 20.00 |
| 11 | R11-3 | A1-11 | 6 | 20.00 |
| 12 | R11-2 | R12-1 | 6 | 7.00 |
| 13 | R14-3 | A1-13 | 6 | 20.00 |
| 14 | Q1-E | A1-E1 | 6 | 4.50 |
| 15 | R15-1 | A1-15 | 6 | 18.50 |
| 16 | P1-P | R14-2 | 6 | 11.00 |
| 17 | P1-H | P1-J | 6 | 2.50 |
| 18 | J3-B | A2-A | 6 | 21.00 |
| 19 | TP3 | A1-19 | 6 | 18.00 |
| 20 | TP4 | R14-2 | 6 | 8.00 |
| 21 | A2-D | A1-21 | 6 | 7.50 |
| 22 | Q1-B | A1-B1 | 6 | 4.50 |
| 23 | P1-N | A1-23 | 6 | 22.00 |
| 24 | P1-T | R10-1 | 6 | 23.00 |
| 25 | R18-3 | A1-25 | 6 | 19.00 |
| 26 | TP1 | A1-26 | 6 | 20.00 |
| 27 | P1-M | TP1 | 6 | 13.00 |
| 28 | P1-G | A1-28 | 6 | 23.00 |

| WIRE NO (REF) | TERMINATION | | | WIRE FIND NO | WIRE CUT LENGTH (REF) |
|---|---|---|---|---|---|
| | FROM | TERM FIND NO (REF) | TO | | |
| 31 | R16-2 | – | A1-31 | 6 | 19.00 |
| 32 | Q1-C | 5 | A1-C1 | 6 | 4.00 |
| 33 | P1-C | – | A1-33 | 6 | 22.00 |
| 34 | P2-A | – | A1-34 | 6 | 20.00 |
| 35 | P1-C | – | A1-35 | 6 | 24.00 |
| 36 | TPC | – | A1-36 | 6 | 19.00 |
| 37 | P5-C | – | TPC | 6 | 8.50 |
| 38 | TPC | – | A1-38 | 6 | 19.00 |
| 39 | P5-D | – | TPD | 6 | 7.00 |
| 40 | TPB | – | A1-40 | 6 | 18.00 |
| 41 | P5-B | – | TPB | 6 | 10.00 |
| 42 | TPA | – | A1-42 | 6 | 18.00 |
| 43 | P1-E | – | A1-43 | 6 | 23.00 |
| 44 | P1-R | – | A1-44 | 6 | 23.00 |
| 45 | P1-S | – | R15-3 | 6 | 12.00 |
| 46 | Q2-E | – | A1-E2 | 6 | 6.00 |
| 47 | Q2-B | – | A1-B2 | 6 | 5.00 |
| 48 | P5-A | – | TPA | 6 | 10.00 |
| 49 | P1-F | – | R15-3 | 6 | 11.00 |
| 50 | A2-C | – | A1-50 | 6 | 11.00 |
| 51 | J3-D | – | A1-51 | 6 | 22.00 |
| 52 | J3-C | – | A1-52 | 6 | 22.00 |
| 53 | R15-2 | – | R16-3 | 6 | 6.50 |
| 54 | Q2-C | 5 | A1-C2 | 6 | 4.00 |
| 55 | P1-U | – | A1-15 | 6 | 23.00 |
| 57 | R15-1 | – | A1-44 | 6 | 18.00 |
| 58 | P2-B | – | A1-33 | 6 | 19.00 |
| 59 | A1-7 | – | L3-1 | 6 | 8.50 |
| 60 | A1-8 | – | L13-2 | 6 | 9.50 |
| 61 | A1-61 | – | R10-2 | 6 | 6.50 |

NOTES:

1. INSTALL CABLE STRAPS, FIND NO. 7, AT 1.5 INTERVALS AND AT EACH CABLE BREAKOUT.
2. CRIMP TERMINALS, FIND NO. 5 IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 19.
3. CONDUCTOR ENDS WITHOUT TERMINALS OR CONNECTORS SHALL BE STRIPPED .25 INCH AND TINNED IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT NO. 5.
4. SOLDER ALL CONNECTORS.
5. EACH WIRE SHALL BE PERMANENTLY AND LEGIBLY IDENTIFIED AT EACH END OF THE WIRE.
6. INSTALL INSULATION SLEEVING, FIND NO. 8 OVER EACH SOLDER CONNECTION TO CONNECTORS (FIND NO. 1, 2, 3 AND 4) AND HEAT SHRINK TO A FIRM FIT. SLEEVING SHALL EXTEND OVER WIRE INSULATION AT A MINIMUM OF .25 IN.

| FIND NO. | SYM | DWG SIZE | PART OR IDENTIFYING NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|---|---|---|
| 8 | | | CL 1 | AR | INSULATION SLEEVING, ELEC, HEAT SHRINKABLE, POLYVINYL CHLORIDE, FLEX CROSSLINKED, .125 MIN ID, AS SUPPLIED, .062 MAX ID X .025 WALL, AFTER UNRESTRICTED SHRINKAGE, AR L | MIL-I-23053/2 |
| 7 | | | MS3367-1-9 | AR | STRAP, CABLE, ADJ, SELF-CLINCHING, PLASTIC, TYPE 1, CL 1, 1.5 MAX BDL DIA, NATURAL | |
| 6 | B | | | AR | WIRE, ELEC, TYPE C-20, 105°C, 1000V | MIL-W-16878/2 |
| 5 | | | MS25036-101 | 2 | TERMINAL, LUB, CRIMP STYLE, COP., TIN PLD. INSUL, RING-TONGUE, BELL-MOUTHED, TYPE II, CL 1, 22-18 TERM. SIZE, NO. 6 STUD SIZE | |
| 4 | M | B | 69-502-5 | 1 | CONN, RECEPTACLE, PN MS3102R-22-14P | |
| 3 | M | B | 69-502-3 | 1 | CONN, RECEPTACLE, PN MS3102R-14S-2S | |
| 2 | M | B | 69-502-4 | 1 | CONN, RECEPTACLE, PN MS3102R-14S-5P | |
| 1 | M | B | 69-502-6 | 1 | CONN, RECEPTACLE, PN MS3102R-10SL-4P | |

Figure 6-73. Precise governor control unit (A23), wiring harness diagram (sheet 2 of 2)

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## Section XI. LOAD MEASUREMENT UNIT

6-224 and 6-225 deleted.

### 6-226. GENERAL.

The load measurement unit is utilized on both precise and utility generator sets. The unit consists of a three phase transformer, rectifiers, and a variable load resistor. It measures the total load on the generator set regardless of power factor or phase and provides a dc voltage output proportional to this load. On precise generator sets, this output signal is applied to the load-sensing circuits in the control unit to provide a load rate signal to the feedback circuit, and a voltage proportional to load that is used for the parallel system. If a dummy load kit is utilized with the generator set, the load measurement unit is interconnected with the kit sensing circuit.

### 6-227. TEST ON EQUIPMENT.

a. Symptom and Isolation of Malfunction. A malfunction of the load measurement unit is not easily detected during single unit operation unless the set is equipped with a dummy load kit and the automatic load removal feature is utilized. Then a malfunction is usually indicated by failure of the dummy load kit automatic removal circuit. When the unit malfunctions in a generator set that is operating in parallel, the malfunction is usually indicated by unequal load sharing. To isolate the malfunction, proceed as follows.

1. Remove connector P16 from load measurement unit and with generator set operating at rated speed and voltage, measure voltage at connector P16, pins A to K, B to L, and C to M; voltage should be 120 VAC nominal. Also measure voltage across connector pins G to D, G to E, and G to F; voltage should be 5.6 VAC at rated load.

2. If above voltages are met, connect connector P16 to load measurement unit. Operate generator set, controlling speed with the manual speed control and check load measurement unit output by removing connector P1 from the governor control unit. Measure voltage across connector P1 pins U(+) and S, voltage should be 9.8 VDC with generator set operating at rated load.

3. If input voltages are correct and the output does not vary between 0 and 9.8 VDC proportional to load, the load measurement unit should be replaced.

b. Removal. Refer to figure 6-74 remove load measurement unit by removing electrical connector and screws.

### 6-228. TEST AND ADJUSTMENT.

a. Connect load measuring unit in test circuit as illustrated in figure 6-76.

b. With 120 volts on M3, no load bank (Rd), and 0 volts indicated on voltmeter (M1), voltmeter (M2) shall indicate 0 to 0.4 VDC. Resistor R1 (17, fig. 6-75), internal to load measuring unit, may be adjusted to obtain this reading.

c. With load on Rd, and 5.6 volts ac indicated on M1, voltmeter M2 shall indicate 12.75 to 13.25 VDC.

d. Select intermediate loads of Rd, and observe that the voltage relationships indicated by M1 and M2 are identical to the relationships indicated by the graph in figure 6-77. Adjust R1 to obtain this relationship.

e. Replace a defective load measuring unit, if voltage relationships do not match the graph.

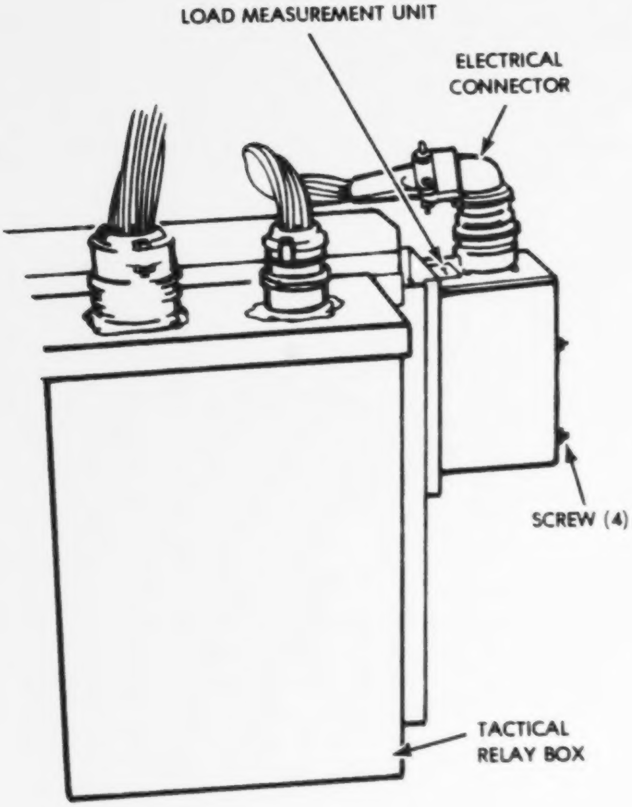

LOAD MEASUREMENT UNIT
ELECTRICAL CONNECTOR
SCREW (4)
TACTICAL RELAY BOX

Figure 6-74. Load measurement unit, removal and installation

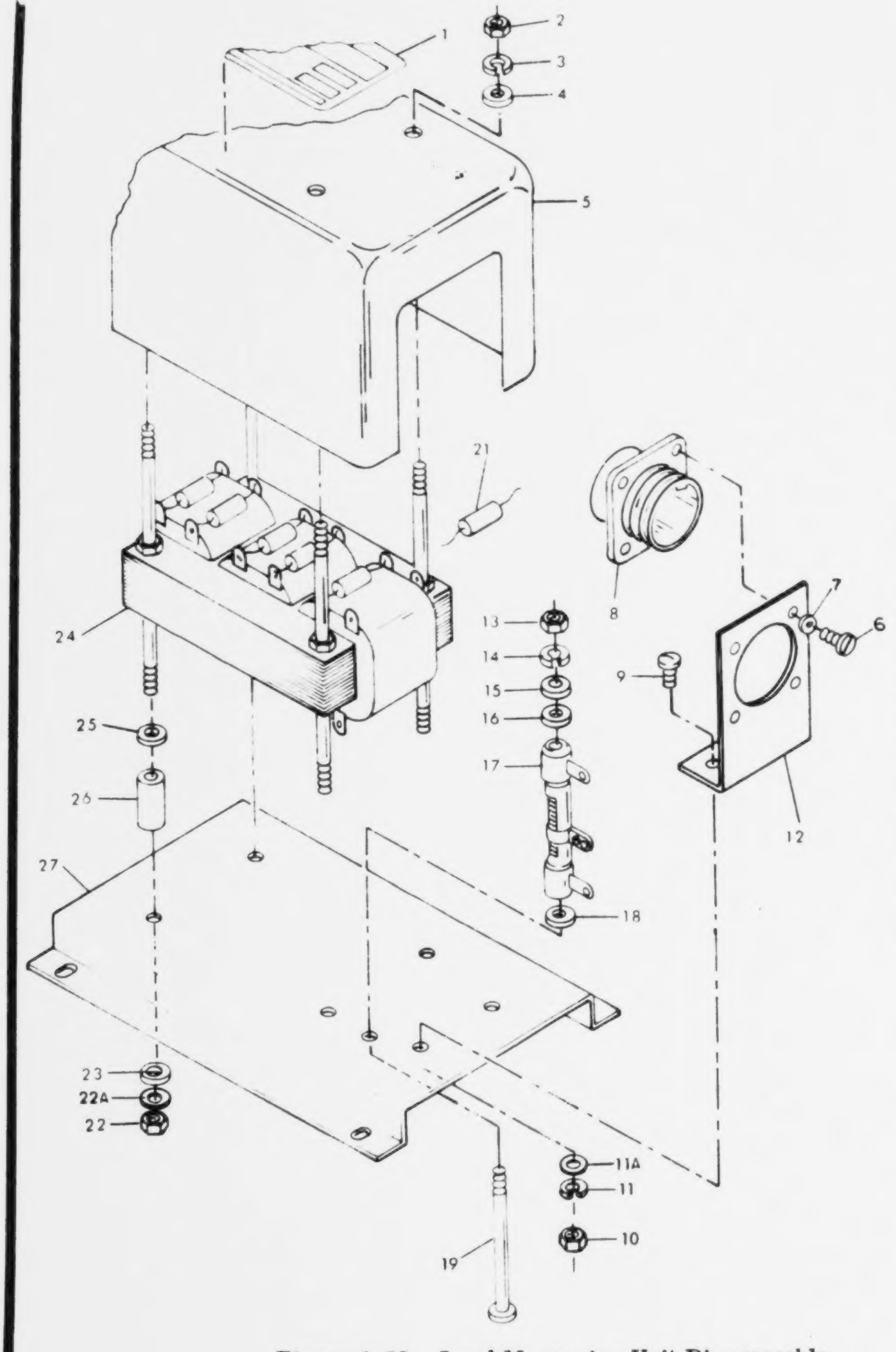
6-229. Repair, Reassembly and Installation.

a. Repair, Replace load measuring unit that does not meet testing requirements.

b. Reassembly. See figure 6-75 and reassemble the load measuring unit.

6-230. INSTALLATION.

Refer to figure 6-69 and install load measurement unit on bracket and secure with screws. Connect electrical connector to unit.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22A
22
11A
11
10
19

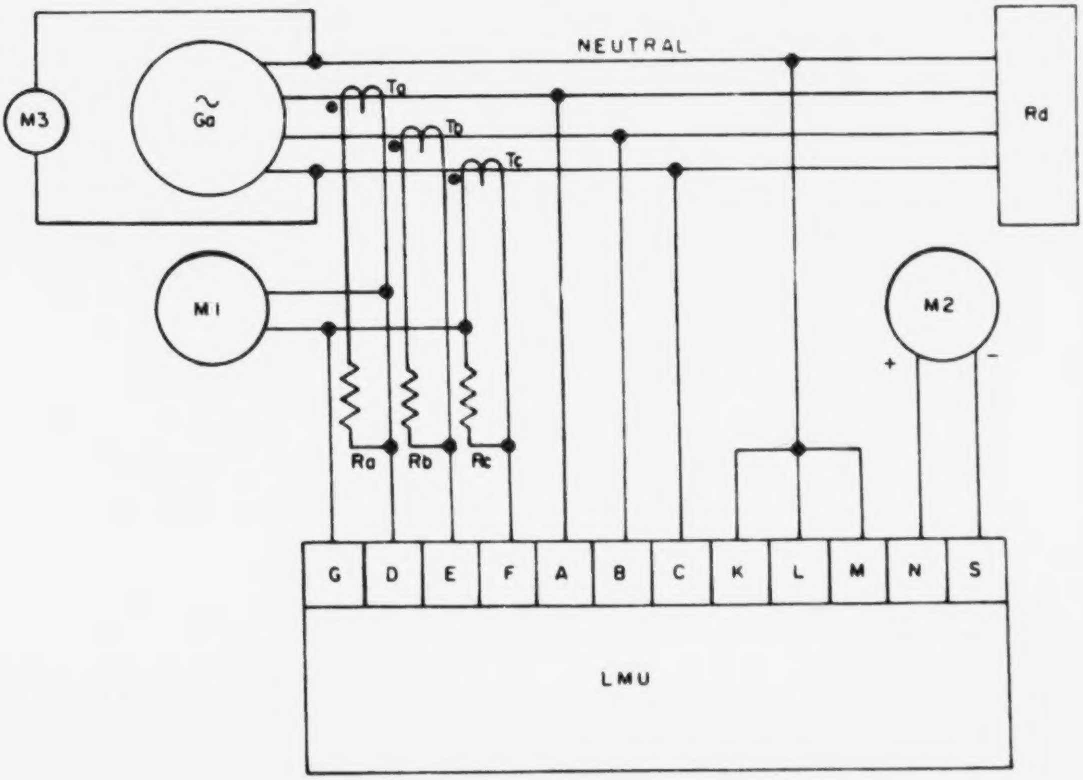
1. Nameplate
2. Nut
3. Washer
4. Washer
5. Cover
6. Screw
7. Washer
8. Harness assy
9. Screw
10. Nut
11. Washer
11A. Washer
12. Bracket
13. Nut
14. Washer
15. Washer
16. Washer
17. Resistor
18. Washer
19. Screw
20. (Deleted)
21. Diode
22. Nut
22A. Washer
23. Washer
24. Transformer assy
25. Washer
26. Sleeve
27. Bracket

Figure 6-75. Load Measuring Unit Disassembly

TEST EQUIPMENT

| REF DESIGNATION | QUANTITY | DESCRIPTION |
|---|---|---|
| Ga | 1 | Power source 208 V, 3 phase, 47-430 Hz |
| Ta, Tb, Tc | 3 | * Current transformers |
| Ra, Rb, Rc | 3 | Load resistors 7.5 ohms, 10 watts |
| Rd | 1 | Load bank |
| M1 | 1 | Voltmeter 0-10 Vac |
| M2 | 1 | Voltmeter 0-50 Vdc |
| M3 | 1 | Voltmeter 0-300 Vac |

* Shall be designed to deliver 0-5.6 volts as load is varied from zero to full load.


NEUTRAL
M3
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Tb
Tc
Rd
M1
M2
+
-
Ra
Rb
Rc
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A
B
C
K
L
M
N
S
LMU

Figure 6-76. Load Measuring Unit Test, Schematic Diagram

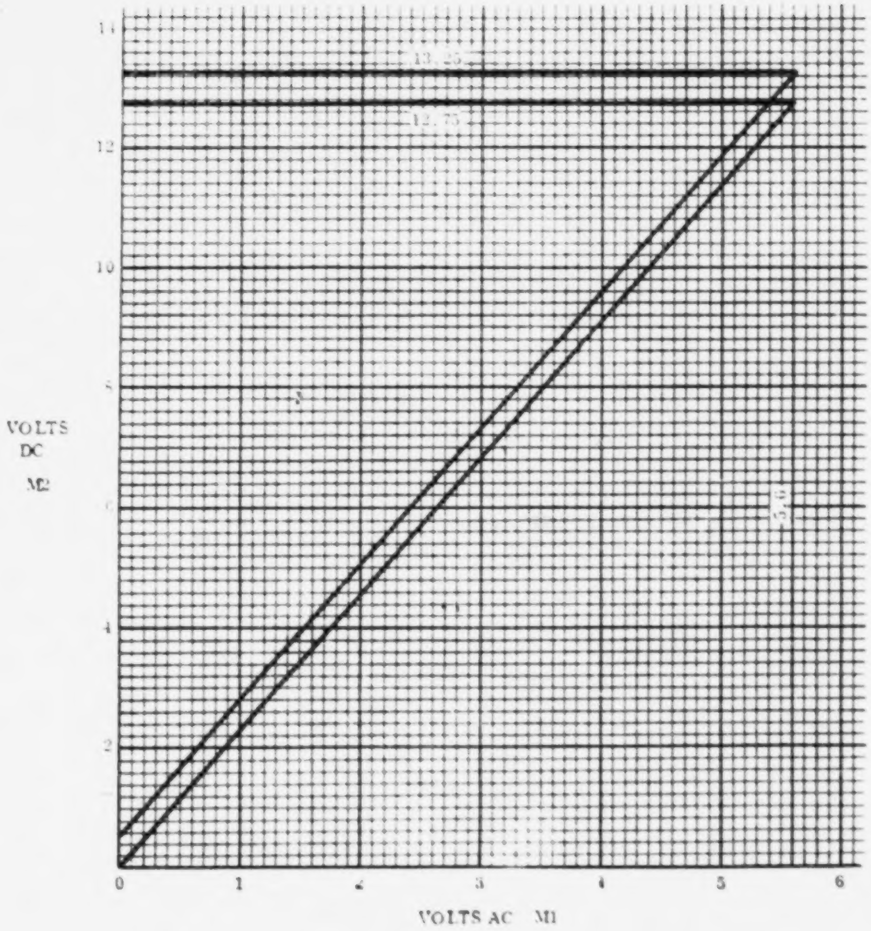

Figure 6-77. Load Measuring Unit Test, Voltage Relationship Graph

All data on pages 6-189 thru 6-192 deleted.

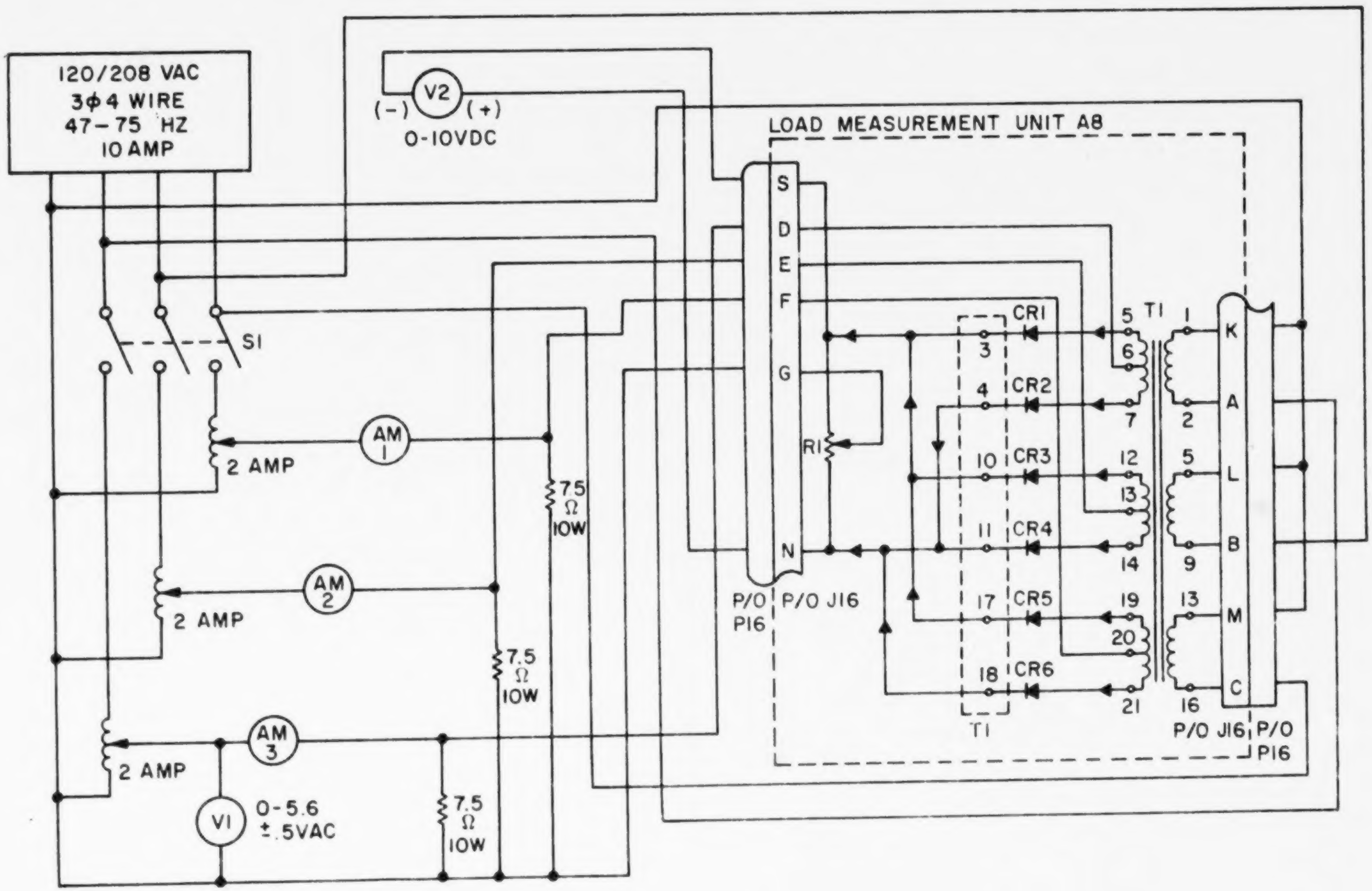
120/208 VAC
3ϕ4 WIRE
47–75 HZ
10 AMP
V2
(−)
(+)
0-10VDC
LOAD MEASUREMENT UNIT A8
S
D
E
F
G
N
P/O P16
P/O J16
R1
S1
AM 1
AM 2
AM 3
2 AMP
2 AMP
2 AMP
7.5 Ω 10W
7.5 Ω 10W
7.5 Ω 10W
V1
0-5.6 ±.5VAC
CR1
CR2
CR3
CR4
CR5
CR6
3
4
10
11
17
18
T1
5
6
7
12
13
14
19
20
21
T1
1
2
5
9
13
16
K
A
L
B
M
C
P/O J16
P/O P16

Figure 6-70. Load measurement unit (LMU), test setup

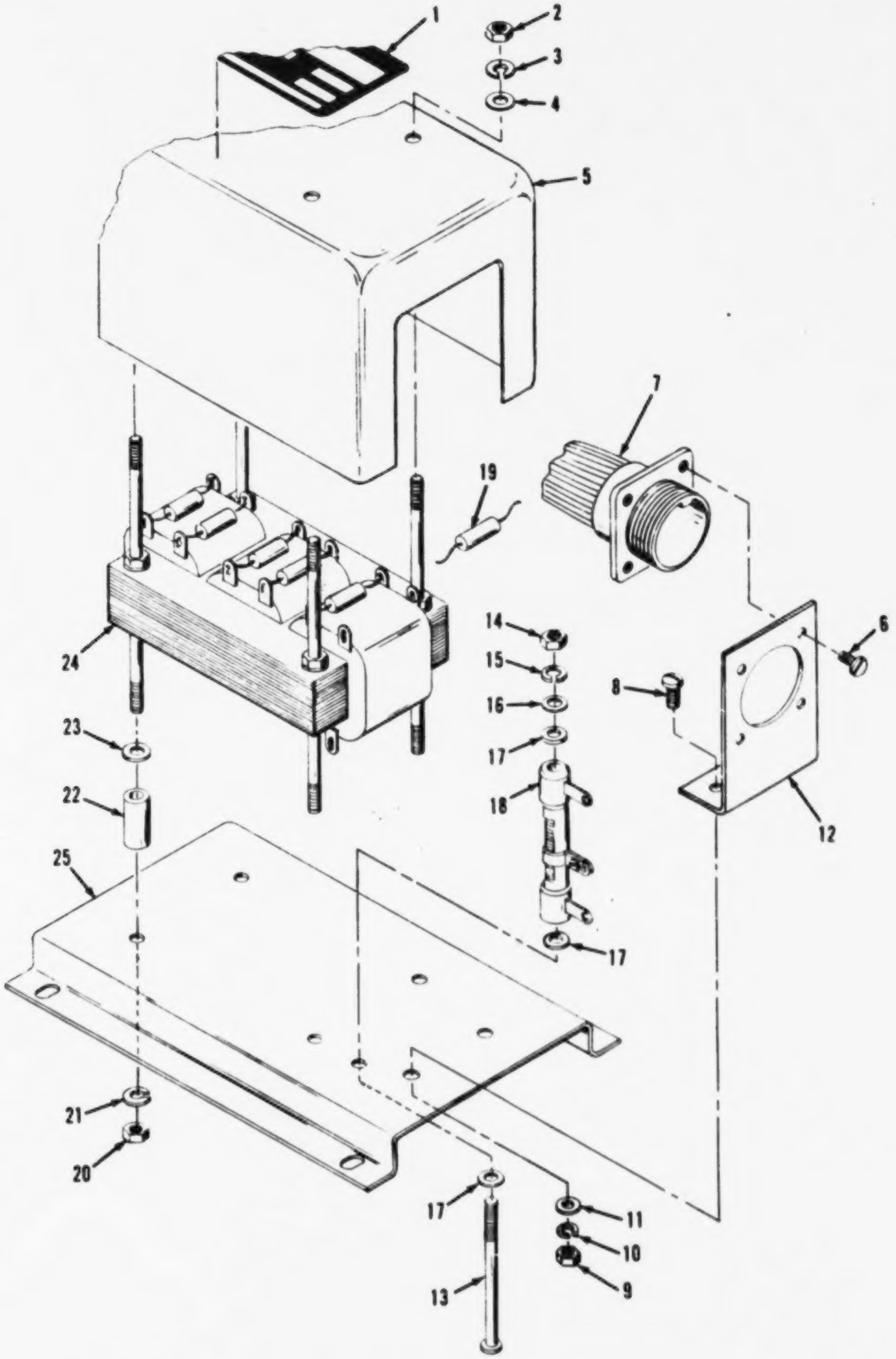
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Figure 6-71. Load measurement unit, exploded view

Legend to figure 6-71:

1. Nameplate
2. Nut (4)
3. Lock washer (4)
4. Washer (4)
5. Cover
6. Screw (4)
7. Receptacle (J16)
8. Screw (2)
9. Nut (2)
10. Lock washer (2)
11. Washer (2)
12. Bracket
13. Screw
14. Nut
15. Lock washer
16. Washer (2)
17. Washer (2)
18. Adjustable resistor (R1)
19. Diode (CR1 through CR6)
20. Nut (4)
21. Lock washer (4)
22. Tube (4)
23. Washer (4)
24. Transformer (T1)
25. Bracket

## 6-233. REASSEMBLY.

Refer to figure 6-71 and reassemble the load measurement unit in the reverse order of index numbers assigned.

a. Solder diodes (19) and wires to transformer (24).

b. Prior to installing cover (5), test and adjust load measurement unit as specified in paragraph 6-228.

c. Install cover after test.

## 6-234. INSTALLATION.

Refer to figure 6-69 and install load measurement unit on bracket and secure with screws. Connect electrical connector to unit.

Table 6-26. Load Measurement Unit Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 1. | Turn on the 120/208 VAC power supply with switch S1 open. | Voltmeter V2 should indicate from 0 to 0.4 VDC. Voltmeter V1 should indicate 0 VAC. | Resistor R1 not adjusted.<br>Defective resistor R1, transformer T1, or diodes CR1 through CR6. | Adjust resistor R1 to obtain required result.<br>Check components with ohmmeter. |
| 2. | Close switch S1 and adjust T1, T2, and T3 so that AM1, 2, and 3 indicate 0.60 amps. | Voltmeter V1 should indicate 5.6 VAC. Voltmeter V2 should indicate 9.4 to 9.8 VDC. | Resistor R1 not adjusted.<br>Defective resistor R1, transformer T1, or diodes CR1 through CR6. | Adjust R1 to obtain required result.<br>Check components with ohmmeter. |

# CHAPTER 7

# GENERATOR ASSEMBLY REPAIR INSTRUCTIONS

## 7-1. GENERAL.

The generator is a brushless type with a rotating exciter. The armature of the exciter, the field of the generator and the rectifier assembly are mounted on the same rotating shaft. The field of the exciter and armature of the generator are stationary. The output of the generator armature is kept at a predetermined constant value by regulation of the exciter field current. In order to build up the generator output voltage, battery voltage is automatically applied to the exciter field from the exciter regulator. This voltage is fed from the exciter armature to the bridge rectifier assembly, the dc output of which is coupled to the generator field rotating on the same shaft with the exciter armature and rectifier assembly. The generator field induces an ac voltage in the stationary armature windings.

## 7-2. ON EQUIPMENT TEST.

a. Symptom and Isolation of Malfunction. A malfunction of the generator is usually indicated by either low output voltage or no voltage output. To isolate the malfunction, proceed as follows.

1. Disconnect generator set air intake doors, below control cubicle, by removing fourteen screws, washers, and nuts.

2. Disconnect generator air inlet louver and screen assembly, by removing twenty screws, forty washers and sixteen nuts.

WARNING

Stay clear of generator output leads.

3. Remove electrical connector P61 from right side of generator endbell.

4. Connect a variable dc voltage supply (0-10 volt, 15 amperes) in series with a 0-10 dc ammeter to connector J61 pin C (positive) and pin B (negative). Set variable voltage supply to zero.

5. Start generator set and operate engine at rated speed, 1800 RPM.

6. Adjust variable voltage supply until normal generator output voltage is obtained (120/208 or 24/416). Test dc ammeter should indicate 2.5 to 3 amperes.

7. Remove external power supply and shut down generator set.

8. If above requirements are met, refer to paragraph 6-68 and test the exciter regulator. If requirements are not met, proceed as indicated below.

NOTE

Generator temperature should be approximately 77°F (25°C) during resistance test.

9. Check resistance between connector J61 pins B and C using a Wheatstone Bridge or other suitable low resistance measuring device. Resistance should be 1.51 ohms ± 10 percent.

10. Check insulation resistance of exciter stator by electrically bonding connector J61 pins B and C together. Connect lead from pins to a 500 volt megger and connect other megger lead to frame. Resistance reading should be a minimum of 50K ohms.

NOTE

Interconnecting wiring information is contained in Operator and Organizational Maintenance Manual.

11. Remove plastic shield from reconnection panel. Remove voltage change over board. Disconnect electrical connector P10 from circuit relay box connector J10, and electrical connector P13 from exciter regulator connector J13. Check resistance between generator leads T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, and T9-T12, using a Kelvin Bridge or other suitable low resistance measuring device. Resistance should be 0.00455 ohm ± 10 percent.

12. Check insulation resistance of main stator by electrically bonding all twelve leads (T1 thru T12) together. Connect a lead from the twelve generator leads to a 500 volt megger and connect other megger lead to frame. Resistance reading should be a minimum of 50K ohms. Connect electrical connector P10 to J10 on mode I relay box and electrical connector P13 to J13 on exciter regulator. Install voltage change over board and plastic shield over the reconnection board.

NOTE

Figure 1-20 is the generator assembly simplified schematic.

13. Disconnect bracket from load connection board by removing two screws, washers, and nuts. Remove bracket from end bell and exciter stator assembly (62, figure 7-1) by loosening screws (60). Remove end bell and exciter stator assembly (62) from generator by removing screws (60) and lock washers (61). Tag and disconnect six diode leads from rectifier assembly (12) and test each diode for an open or short.

14. Tag and disconnect two main rotor leads from rectifier assembly. Check resistance between two stator leads using a Kelvin Bridge or other suitable low resistance measuring device. Resistance should be 0.746 ohm ± 10 percent.

15. Check insulation resistance of main rotor by electrically bonding the two leads together. Connect leads to a 500 volt megger and connect other megger lead to rotor shaft. Resistance reading should be a minimum of 50K ohms.

16. Tag and disconnect three exciter rotor leads from rectifier assembly. Check resistance between exciter rotor leads R1-R2 and R1-R3, using a Kelvin Bridge or other suitable low resistance measuring device. Resistance should be 0.0755 ohm ± 10 percent.

17. Check insulation resistance of exciter rotor by electrically bonding the three leads together. Connect leads to a 500 volt megger and connect other megger lead to rotor shaft. Resistance reading should be a minimum of 50K ohms.

18. Connect main stator, exciter rotor, and diode leads to rectifier assembly. Install end bell and exciter stator assembly (62) with screws (60) and lock washers (61). Replace bracket (reference step 13 preceding), then connect electrical

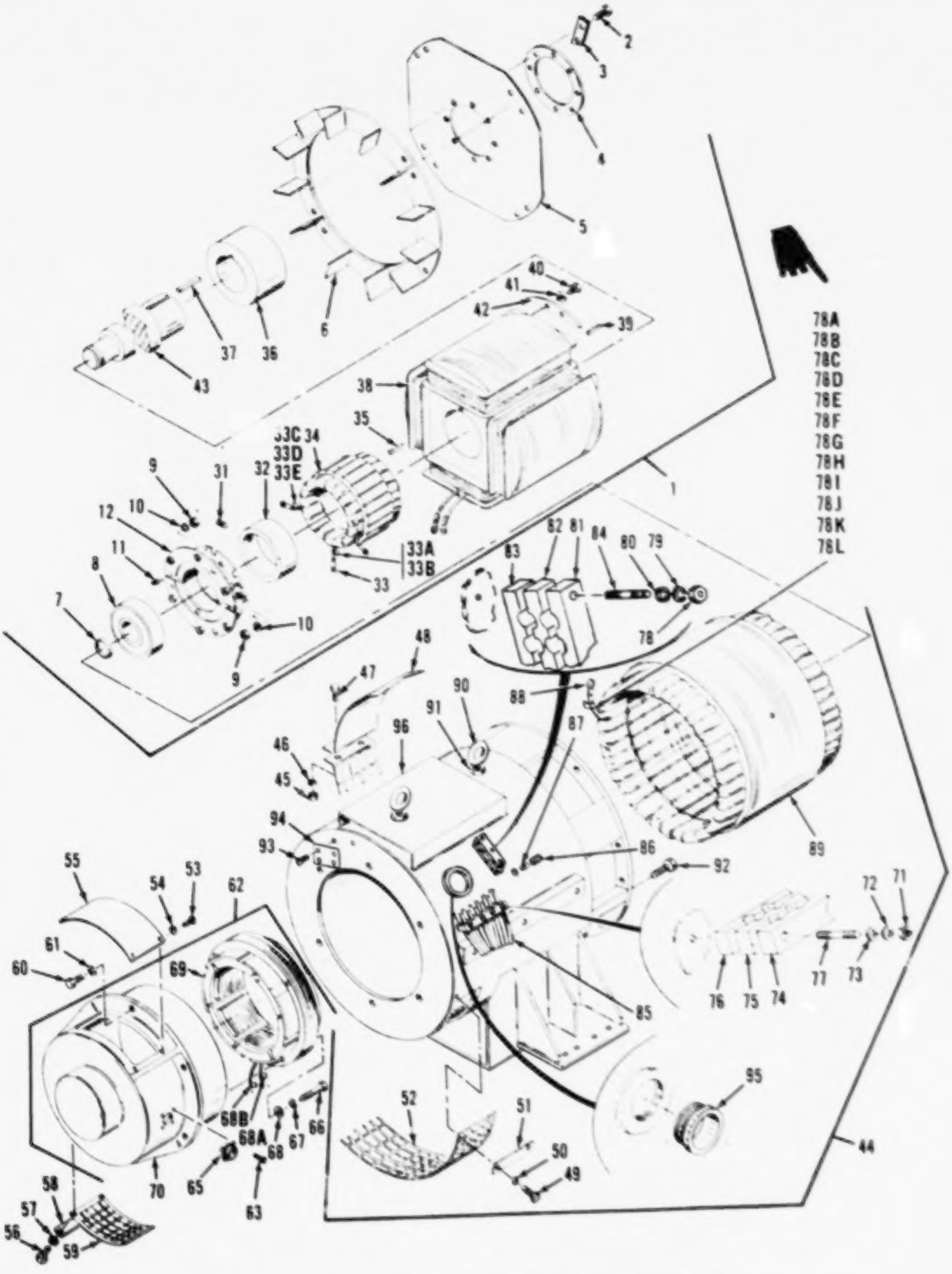
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Figure 7-1. Generator assembly, exploded view
(sheet 1 of 2)

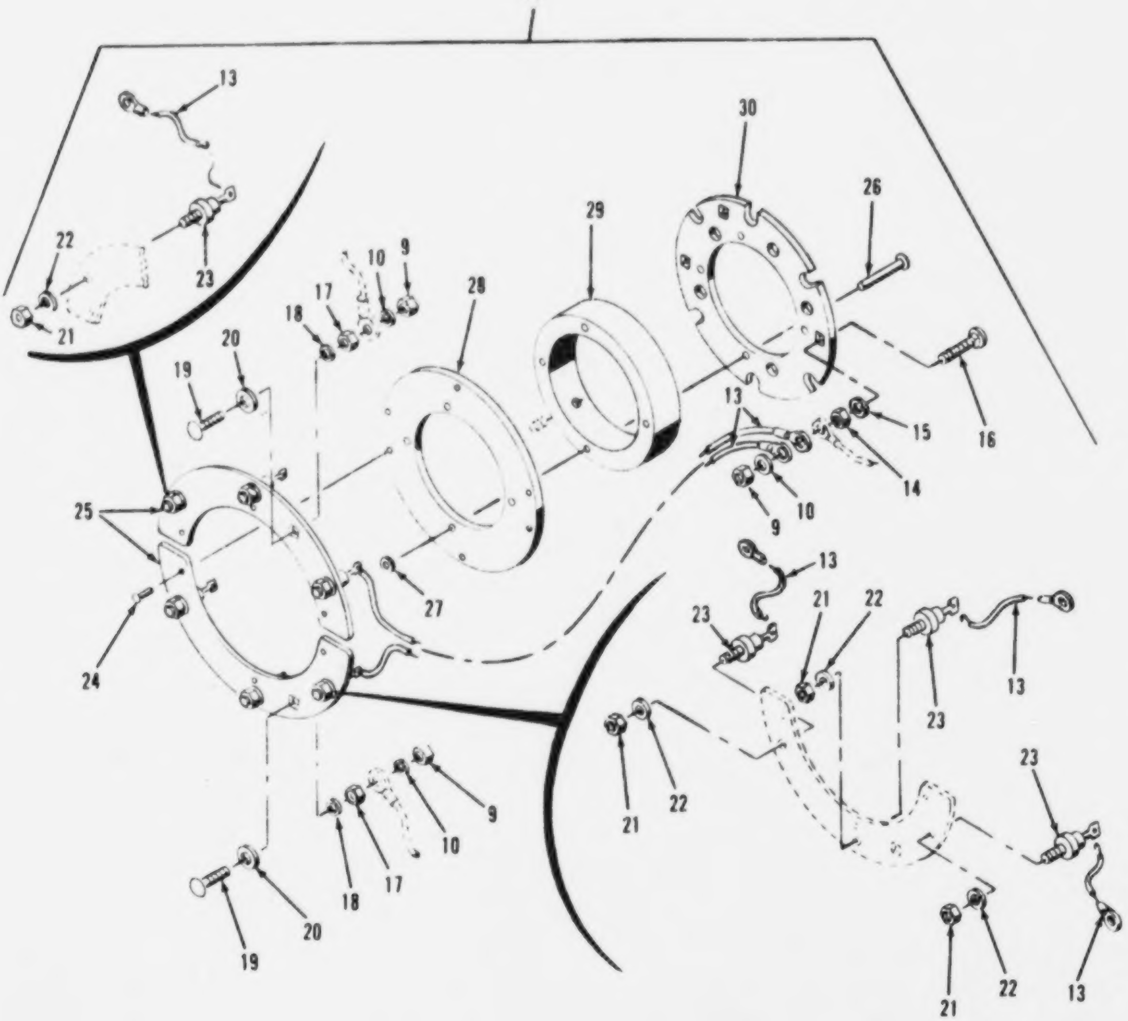
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Figure 7-1. Generator assembly, exploded view
(sheet 2 of 2)

connector P61 to electrical connector J61 on generator end bell. Install generator air inlet louver and screen assembly and secure with screws, washers, and nuts. Install generator set air intake doors and secure with screws, washers, and nuts.

b. REMOVAL. Remove the generator as specified in paragraph 2-7.

## 7-3. DISASSEMBLY.

Refer to figure 7-1 and disassemble generator in the order of index numbers

Legend to figure 7-1:

1. Main rotor and shaft assembly
2. Screw (8)
3. Clip locks (4)
4. Retainer
5. Shaft coupling (3)
6. Fan
7. Snap ring
8. Bearing
9. Nut (5)
10. Lock washer (5)
11. Setscrew
12. Rectifier assembly
13. Diode lead (6)
14. Nut (3)
15. Lock washer (3)
16. Bolt (3)
17. Nut (2)
18. Lock washer (2)
19. Screw (2)
20. Washer (2)
21. Nut (6)
22. Lock washer (6)
23. Diode (6)
24. Rivet (6)
25. Heatsink (2)
26. Rivet (6)
27. Washer (4)
28. Plate
29. Hub
30. Insulator
31. Setscrew
32. Spacer
33. Terminal lub (5)
33A. Wire Marker
33B. Wire Marker
33C. Wire Marker
33D. Wire Marker
33E. Wire Marker
34. Exciter rotor assembly
35. Key
36. Hub
37. Key
38. Main rotor subassembly
39. Key
40. Screw (AR*)
41. Lock washer (AR*)
42. Balance weight (AR*)
43. Shaft
44. Main stator and frame assembly
45. Nut (4)
46. Lock washer (4)
47. Screw (4)
48. Screen
49. Screw (4)
50. Lock washer (4)
51. Clip (2)
52. Screen
53. Screw (4)
54. Lock washer (4)
55. Cover
56. Screw (4)
57. Lock washer (4)
58. Clip (2)
59. Screen
60. Screw (6)
61. Lock washer (6)
62. End bell and exciter stator assembly
63. Screw (4)
64. Deleted
65. Connector
66. Screw (6)
67. Lock washer (6)
68. Washer (6)
68A. Wire marker
68B. Wire marker
69. Exciter stator assembly
70. End bell
71. Nut (3)
72. Lock washer (3)
73. Washer (3)
74. Clamp
75. Clamp
76. Clamp
77. Stud
78. Nut (3)
78A. Wire marker (2)
78B. Wire marker (2)
78C. Wire marker (2)
78D. Wire marker (2)
78E. Wire marker (2)
78F. Wire marker (2)
78G. Wire marker (2)
78H. Wire marker (2)
78I. Wire marker (2)
78K. Wire marker (2)
78L. Wire marker (2)
79. Lock washer (3)
80. Washer (3)
81. Clamp
82. Clamp
83. Clamp
84. Stud (3)
85. Lead (12)
86. Setscrew (2)
87. Lock pin (2)
88. Terminal lug (12)
89. Main stator assembly
90. Lifting eye bolt (2)
91. Nut (2)
92. Screw (8)
93. Screw (4)
94. Nameplate
95. Insulation bushing
96. Main stator frame

assigned. Pay particular attention to the following.

a. Before disassembly, insure that shipping block (refer to table 2-2) is installed on main stator and frame assembly (44) and fan (6) is secure to shaft couplings (5).

WARNING

Insure that generator is properly blocked to prevent injury to personnel during disassembly.

b. Attach a suitable cable hook and lifting device to generator lifting eyes (90).

Position generator in a vertical position resting generator end bell and exciter stator assembly (62) on wooden blocks. Position two each twelve inch by twelve inch wooden blocks under generator mounting brackets on frame assembly (96) to prevent generator from tipping over. Remove lifting device.

c. Remove moving block. Bend down corners of clip locks (3) and using a suitable tool hold shaft couplings (5) and remove two screws (2) 180 degrees apart. Install lifting fixture (figure 2-1, view B) and secure with two (0.500-20 x 3.00) screws to main rotor and shaft assembly (1). Install lifting eyebolt (90) in lifting fixture. Using a cable hook and lifting device, lift main rotor and shaft assembly (1) from main stator and frame assembly (44).

d. Place main rotor and shaft assembly (1) on a bench resting the main rotor subassembly (38) on cushion material, to prevent damage. Allow fan (6) and shaft coupling (5) to hang over side of bench.

e. Remove lifting eyes from main rotor and shaft assembly (1).

f. Remove screws (2), clip locks (3), retainer (4), shaft couplings (5), and fan (6). Disconnect fan (6) from shaft couplings (5) by removing shipping screws and nuts.

CAUTION

Do not remove bearing (8) unless proven defective at time of inspection or further disassembly is required.

g. Remove snap ring (7) and using a suitable puller, remove bearing (8) from shaft (43).

h. Tag and disconnect electrical leads from rectifier assembly (12) by removing nuts (9) and lock washers (10). Remove setscrew (11) and remove rectifier assembly (12) from shaft (43).

NOTE

Do not disassemble rectifier assembly unless proven defective at time of inspection.

i. Disassemble rectifier assembly (12) as follows.

1. Disconnect diode leads (13).

2. Remove diodes (23) from heat sinks (25).

3. Unsolder leads (13) from diodes (23) using suitable soldering equipment.

4. Remove heat sinks (25) from plate (28) by removing rivets (24).

5. Separate insulator (30), hub (29), and plate (28).

j. Remove setscrew (31) and using a suitable puller, remove spacer (32), exciter rotor assembly (34), and key (35) from shaft (43).

CAUTION

Do not remove main rotor subassembly (38) from shaft (43) unless found defective at inspection.

k. Using a suitable puller, remove hub (36) and key (37) from shaft (43).

l. Using a suitable press, press shaft (43) from main rotor subassembly (38) and remove key (39).

m. Turn main stator and frame assembly (44) over and position frame assembly on wooden blocks with end bell on top. Block assembly to prevent tipping.

n. Remove screens (48, 52, and 59) and cover (55).

o. Remove end bell and exciter stator assembly (62).

p. Lift connector (65) from side or end bell (70), tag and unsolder exciter stator (69) leads from connector (65). Remove exciter stator assembly (69) from end bell assembly.

**CAUTION**

Remove main stator assembly (89) only if found defective at time of inspection.

q. Remove clamps (74 thru 76 and 81) thru 83).

r. Remove two setscrews (86) and using 0.1250 inch drill, drill a hole 0.375 inch deep in each pin (87). Using an easy out tool remove pins and remove main stator assembly (89) from main stator frame (96) using a suitable puller.

s. Remove screw (92) from main stator frame (96).

## 7-4. CLEANING.

a. Use a clean cloth and low-pressure compressed air (10-15 pounds pressure) and remove dust and dirt from windings and frame.

b. Use a clean lint-free cloth moistened with an approved cleaning solvent to remove heavy deposits from windings and dry thoroughly.

c. Clean rectifier assembly with a clean lint-free cloth moistened with an approved cleaning solvent and dry thoroughly.

d. Clean all metal parts with an approved cleaning solvent and dry thoroughly.

## 7-5. INSPECTION.

a. Inspect generator frames for cracks and burred mating surfaces.

b. Inspect generator frames for cracked welds and distortion.

c. Inspect shaft couplings for distortion and elongated holes.

d. Inspect shaft for nicks and scratches.

e. Inspect fan for distortion, elongated holes, cracked welds, or chipped blades.

f. Inspect screens for distortion and bent corners.

g. Inspect nuts, bolts, and screws for damaged threads and heads.

h. Rotate bearing and check for freedom of movement, flat spots, binding, and signs of overheating. Measure bearing inside diameter, diameter should be $2.7559 \begin{matrix} +0.0000 \\ -0.0008 \end{matrix}$ inches. Measure bearing outside diameter, diameter should be $5.9005 \begin{matrix} +0.0000 \\ -0.0008 \end{matrix}$ inches.

i. Measure shaft bearing contact surface, shaft should be 2.7565 to 2.7560 inches.

j. Measure end bell bearing contact, end bell should be 5.9062 to 5.9055 inches.

NOTE

Generator windings temperature should be approximately 77°F during resistance checks. Resistance checks should be made using a Kelvin Bridge for resistance values below one ohm, and a Wheatstone Bridge for values above one ohm. Other suitable low resistance type measuring devices may be used. Resistance values of windings are to be within a tolerance of ±10 percent.

k. Check main stator resistance values between leads: T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, and T9-T12. Resistance should be 0.00455 ohm.

l. Check main rotor resistance value between leads R4 and R5. Resistance should be 0.746.

m. Check exciter rotor resistance values between leads R1-R2 and R1-R3. Resistance should be 0.0606 ± 10%.

n. Check exciter stator resistance value between leads F1 and F2. Resistance should be 1.51 ohms.

NOTE

Generator windings insulation resistance checks should be made using a 500 volt megger. Resistance readings should be a minimum of 50K ohms.

o. Check insulation resistance of main stator windings by electrically bonding all twelve leads together and connecting a megger between leads and stator frame.

p. Check insulation resistance of main rotor winding by electrically bonding rotor leads together and connect a megger between leads and rotor frame or rotor shaft.

q. Check insulation resistance of exciter rotor winding by electrically bonding the three rotor leads together and connecting a megger between leads and rotor frame or rotor shaft.

r. Check insulation resistance of exciter stator winding by electrically bonding stator leads together and connecting a megger between leads and rotor frame.

s. Inspect rectifier assembly as follows:

1. Disconnect diodes from the rectifier assembly and test each diode separately using a suitable multimeter.

2. Connect the multimeter across the diode, meter positive lead on the anode (back end of arrow) and negative meter lead on the cathode (tip of the arrow). A low resistance should be indicated.

3. Reverse multimeter leads, a high resistance (several K ohms) should be indicated.

t. Inspect paint for damage.

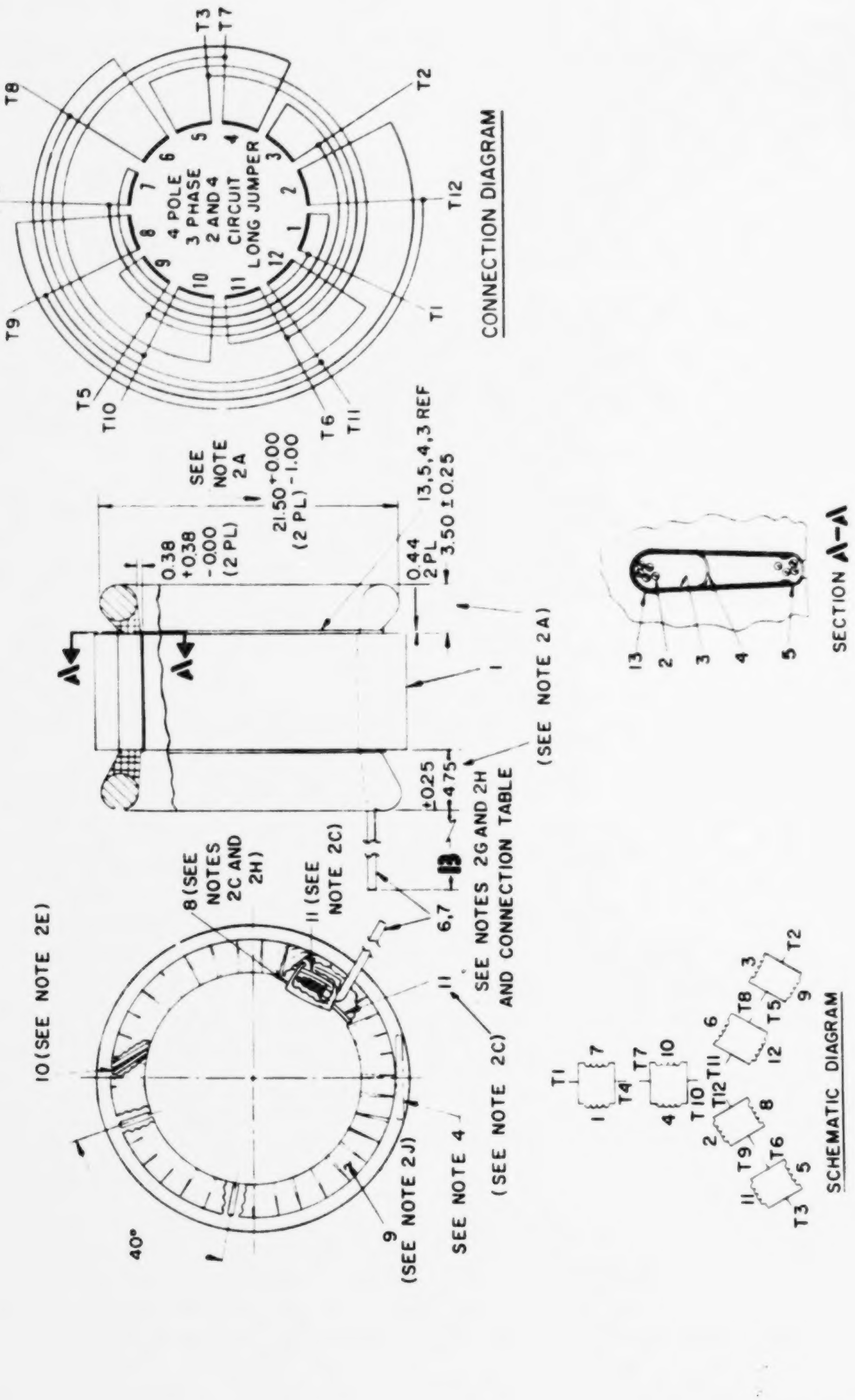
## 7-6. REPAIR OR REBUILD.

a. Repair cracks by welding as long as it does not distort or impair strength of part.

b. Remove burrs or nicks using a suitable file or stone.

c. Straighten dented or distorted sheet metal parts using suitable tools.

d. Repair or rebuild main stator assembly as specified in figure 7-2.


CONNECTION DIAGRAM
4 POLE
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SEE NOTE 2A
21.50 +.000 -1.00 (2 PL)
13,5,4,3 REF
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(SEE NOTE 2A)
A
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SEE NOTES 2G AND 2H AND CONNECTION TABLE
11 (SEE NOTE 2C)
8 (SEE NOTES 2C AND 2H)
10 (SEE NOTE 2E)
11
(SEE NOTE 2C)
SEE NOTE 4
9 (SEE NOTE 2J)
40°
SECTION A-A
13
2
3
4
5
SCHEMATIC DIAGRAM
T1
7
1
T4
T7
10
4
T10
T12
2
8
T11
6
T8
T5
12
3
T2
9
T9
T6
11
5
T3

Figure 7-2. Generator, main stator rewind data (sheet 1 of 2)

NOTES:

1. COIL DATA:
   - A. WIRE SIZE: .064 DIA (#14 GA) CLASS 155, TYPE L2.
   - B. NUMBER OF WIRES PER TURN: 18
   - C. NUMBER OF TURNS PER COIL: 2
   - D. NUMBER OF WIRES PER COIL: 36
   - E. COIL GROUPING: 12 GROUPS OF 6 COILS.
   - F. COIL SPAN: SLOTS 1 AND 13.
2. STATOR WINDING PROCEDURE:
   - A. WIND COILS TO PROPER SHAPE, SPECIFIED DIMENSIONS AND NUMBER OF TURNS.
   - B. HOLD COILS TOGETHER WITH TAPE, INDEX 9.
   - C. APPLY SLEEVING, INDEX 11, AND INDEX 8, (LOOSE).
   - D. SELECT AN ARBITRARY SLOT ON CORE, INDEX 1, AND INSERT FIRST COIL GROUP WITH START LEAD IN THE BOTTOM OF SLOT NO. 1 AND THE ENDING LEAD IN THE TOP OF SLOT NO. 13 (COIL SPAN 1 AND 13).
   - E. INSERT THE NEXT COIL GROUP PER ABOVE GROUPING SEQUENCE. INSERT PHASE INSULATION, INDEX 10, DURING PLACING OF COILS. REPEAT SEQUENCE UNTIL WINDING IS COMPLETE.
   - F. MAKE PHASE CONNECTION PER CONNECTION DIAGRAM (HOMOGENEOUS WELD).
   - G. CONNECT LEADS, INDEX 6 AND 7 INDIVIDUALLY AND ISOLATED FROM EACH OTHER WITH INDEX 8 PER CONNECTION TABLE (HOMOGENEOUS WELD WIRE ENDS).
   - H. APPLY SLEEVING, INDEX 8, OVER LEAD, INDEX 6 AND 7, CONNECTIONS AND PHASE CONNECTIONS.
   - J. WRAP WINDING WITH TAPE, INDEX 9.
3. VARNISH AS FOLLOWS:
   - STEP 1: PREBAKING -
     PUT INTO OVEN AT 110° C(230° F) HOLD AT TEMPERATURE FOR 4 HOURS. COOL TO APPROXIMATELY 50° C(122° F).
   - STEP 2: DIPPING -
     IMMERSE IN VARNISH, MIL-I-24092, UNTIL BUBBLING CEASES. VISCOSITY SHALL BE HELD TO 60 ZAHN SECONDS USING NO. 2 CUP. THIN WITH SOLVENT, MIL-N-15178, TYPE A/B.
   - STEP 3: DRAINING -
     DRAIN AND AIR DRY FOR 1 HOUR. ROTATE WOUND APPARATUS TO PREVENT POCKETING THE VARNISH.
   - STEP 4: WIPING -
     AFTER DRAINING BUT BEFORE BAKING, THE METAL SURFACES OF THE ARMATURE, THE BORE OF THE STATOR AND THE POLE FACES OF THE FIELD STRUCTURE SHALL BE WIPED WITH A CLOTH MOISTENED WITH SOLVENT, MIL-N-15178, TYPE A/B.
   - STEP 5: BAKING -
     BAKE IN CIRCULATING TYPE, FORCED EXHAUST, BAKING OVEN AT TEMPERATURE OF 165° C(329 F).
   - STEP 6: COOLING -
     REMOVE FROM OVEN AND COOL TO APPROXIMATELY 50° C(122° F).
   - STEP 7: SECOND TREATMENT (DIP IN OPPOSITE DIRECTION) - REPEAT STEPS 2 (IMMERSE FOR 1 MINUTE), 3, 4, 5, AND 6.
   - STEP 8: THIRD TREATMENT (DIP IN ORIGINAL DIRECTION) - REPEAT STEPS 2 (IMMERSE FOR 1 MINUTE), 3, 4, 5, AND 6.
4. STAMP PART NUMBER AS SHOWN BELOW PER MIL-STD-130, 0.12 MIN HEIGHT. USING WHITE ENAMEL PAINT.
5. AFTER REWINDING, PERFORM INSPECTION SPECIFIED IN 7-5, STEPS K AND O.

CONNECTION TABLE

| INDEX NO | LEAD NO. | **B** LEAD LENGTH (INCHES) |
|---|---|---|
| 6 | T1, T2, T3,<br>T7, T8, T9 | 90.00 Min |
| 7 | T4, T5, T6,<br>T10, T11, T12 | 54.00 Min |

Figure 7-2. Generator, main stator rewind data (sheet 2 of 2)

Legend to figure 7-2:

1. Stator core
2. Magnet wire 0.064 DIA (#14)
3. Slot cell insulation (72)
4. Center spacer 0.032 thick
5. Wedge (72)
6. Lead (6)
7. Lead (6)
8. Insulation sleeving 0.750 ID
9. Untreated glass tape 0.010 x 0.75
10. Phase insulation
11. Insulation sleeving 0.330 ID
12. Varnish
13. Insulation slot cell (72)

e. Repair or rebuild main rotor assembly as specified in figure 7-3.

f. Repair or rebuild exciter rotor assembly as specified in figure 7-4.

g. Repair or rebuild exciter stator assembly as specified in figure 7-5.

h. Remove damaged paint with a suitable scraper. Blend in edges, prime, and paint damaged areas.

## 7-7. REASSEMBLY.

Refer to figure 7-1 and reassemble generator in the reverse sequence of index numbers assigned. Pay particular attention to the following.

a. Install screws (92) into main stator frame (96) and torque to 90 ft. lbs.

NOTE

**Figure 1-20 is the generator assembly simplified schematic diagram.**

b. Heat main stator frame (96) in a suitable oven to 200°F for ease of installing main stator assembly (89).

c. Place heated main stator frame assembly (96) in a vertical position, resting exciter end on wooden blocks.

CAUTION

Exercise care when installing main stator assembly (89) into main stator frame (96) to prevent damage to windings.

d. Position main stator assembly (89) so that pin (84) holes are aligned with holes in main stator frame (96). Start leads (85) through insulation bushing (95). Pull leads and slide main stator assembly (89) into main stator frame (96) until pin (87) holes are aligned.

e. Install setscrew and pin assembly (86) and tighten to 5 foot-pound torque.

f. Cut output leads (85) to lengths specified in table 7-1. Strip insulation back 0.62 inch and install terminal lugs on leads (85).

g. Position clamp (76) on generator and install generator output leads (85) in the following sequence starting at exciter end: T2, T5, and T10. Install clamp (75) and install following output leads starting at exciter end: T8, T4, and T11. Install clamp (74) and tighten nuts (71).

h. Position clamp (83) on generator and install generator output leads (85) in the following sequence starting at top of generator: T3, T12, and T9. Install clamp (82)

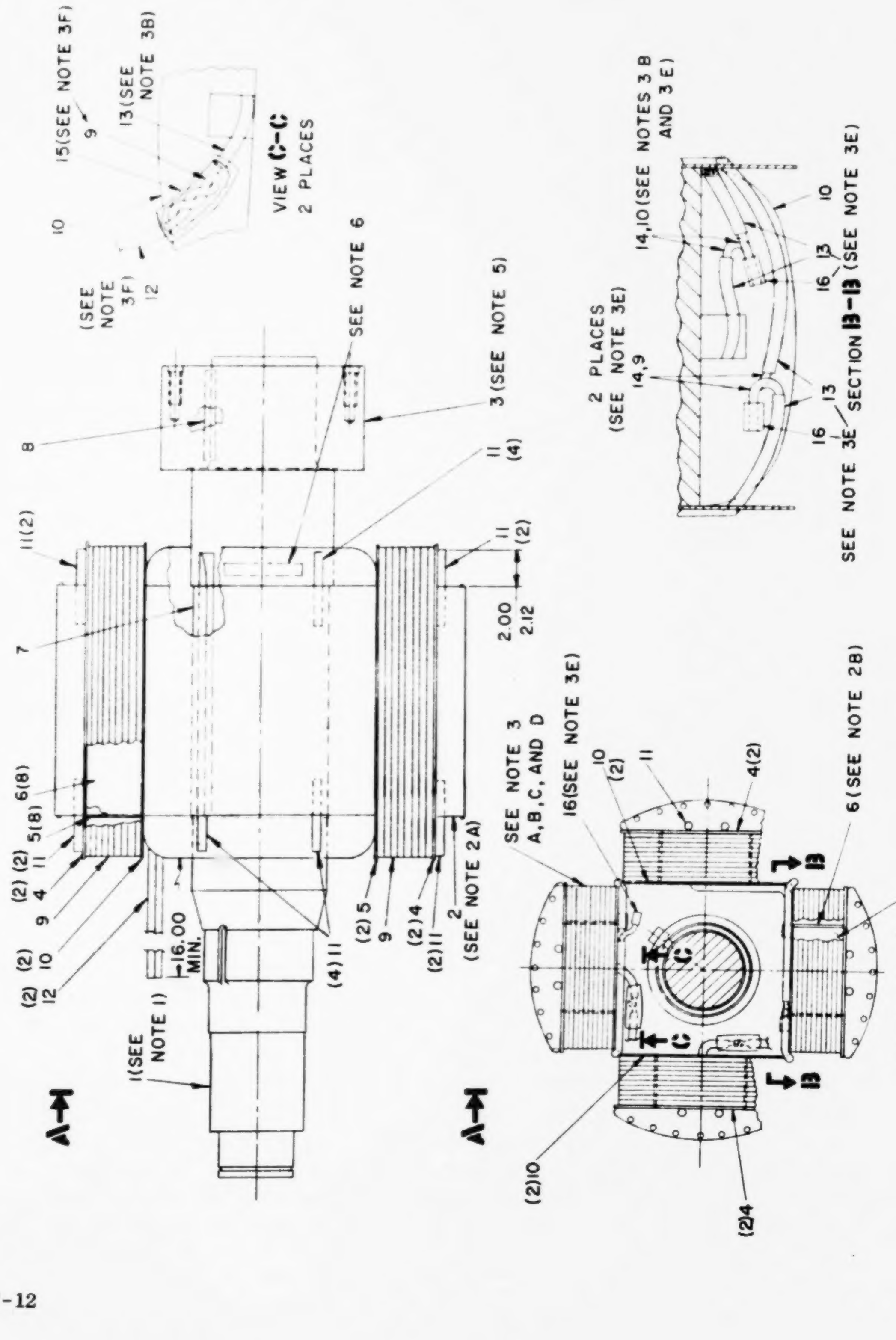

15(SEE NOTE 3F)
9
13(SEE NOTE 3B)
10
(SEE NOTE 3F) 12
VIEW C-C
2 PLACES
SEE NOTE 6
3(SEE NOTE 5)
8
11 (4)
11(2)
7
2.00
2.12
11 (2)
6(8)
5(8)
(2) 11
(2) 4
9
(2) 10
(2) 12
16.00 MIN.
1(SEE NOTE 1)
(4) 11
(2) 5
9
(2) 4
(2) 11
2 (SEE NOTE 2A)
A
A
2 PLACES (SEE NOTE 3E)
14,9
16
13
SEE NOTE 3E
14,10(SEE NOTES 3B AND 3E)
10
16
13
SECTION B-B (SEE NOTE 3E)
SEE NOTE 3 A,B,C, AND D
16(SEE NOTE 3E)
10 (2)
11
4(2)
6(SEE NOTE 2B)
5(SEE NOTE 2B)
B
B
C
C
(2)10
(2)4
SECTION A-A

Figure 7-3. Generator, main rotor rewind data (sheet 1 of 2)

NOTES:

1. PRESS SHAFT, INDEX 1, INTO CORE, INDEX 2, TO SHOULDER ON SHAFT INDEX 1.
2. INSULATING:
   A. APPLY EPOXY, INDEX 14, TO POLE BOTTOM, POLE SIDES AND POLE ENDS.
   B. INSTALL INSULATION, INDEX 10, ON BOTTOM POLE SIDES. INSTALL INSULATION, INDEX 4, ON TOP POLE SIDES. INSTALL INSULATION, INDEX 5 AND 6, ON POLE ENDS.
3. WINDING:
   A. ADJUST WIRE TENSION, INDEX 9, TO 70 LBS.
   B. APPLY SLEEVE, INDEX 13, TO START LEAD OF EACH COIL.
   C. WIND THE FIRST LAYER WITH 9 TURNS TO FILL THE WINDING SPACE. FORM THE COIL SIDES WITH A FIBRE BLOCK TO OBTAIN FLAT AND TIGHT WINDING. DO NOT FORM COIL ENDS. APPLY EPOXY, INDEX 14.
   D. CONTINUE WINDING COMPLETE COIL AS DESCRIBED IN WINDING NOTE 3C, MAKING SURE TO APPLY EPOXY, INDEX 14, TO COVER ALL TURNS AND TO FILL ALL VOIDS THROUGH THE ENTIRE WINDING. THIS WILL REQUIRE BRUSHING EPOXY ON ALL LAYERS. FORM COIL SIDES WHILE WINDING TO PRODUCE FLAT SIDES. WIND EACH COIL WITH 162 TURNS, 9 TURNS PER LAYER, 4 COILS.
   E. APPLY SLEEVING, INDEX 13, TO ENDING LEAD OF EACH COIL. SELECT START LEAD OF ARBITRARY COIL AND CONNECT COILS IN SERIES, APPLY TERMINAL, INDEX 16 AND HOMOGENOUS WELD.
   F. CONNECT LEADS, INDEX 12, TO REMAINING TWO LEADS, SOLDER USING SOLDER, INDEX 17.
4. BAKE COMPLETED ROTOR FOR A MIN. OF 24 HOURS AT 325° F to 350°F.
5. HEAT HUB, INDEX 3, TO 400° F THEN SHRINK FIT ON SHAFT, INDEX 1, TO SHOULDER.
6. STAMP PART NUMBER AS SHOWN BELOW PER MIL-STD-130, 0.12 MIN HEIGHT, USING WHITE ENAMEL PAINT.
   30554 ASSY 70-4525
   MFG (MFG CODE)
7. AFTER REWINDING, PERFORM INSPECTION SPECIFIED IN PARAGRAPH 7-5, STEPS I AND P.

Figure 7-3. Generator, main rotor rewind data (sheet 2 of 2)

Legend to figure 7-3:

1. Shaft
2. Rotor core
3. Drive hub coupling
4. Pole insulation (8)
5. Pole insulation (8)
6. Pole insulation (8)
7. Key
8. Key
9. Magnet wire HPT 0.085 x 0.265
10. Pole insulation (8)
11. Pin (16)
12. Lead (2)
13. Insulation sleeving 0.234 ID
14. Epoxy compound
15. Insulation sleeving 0.512 ID
16. Splice (3)
17. Solder

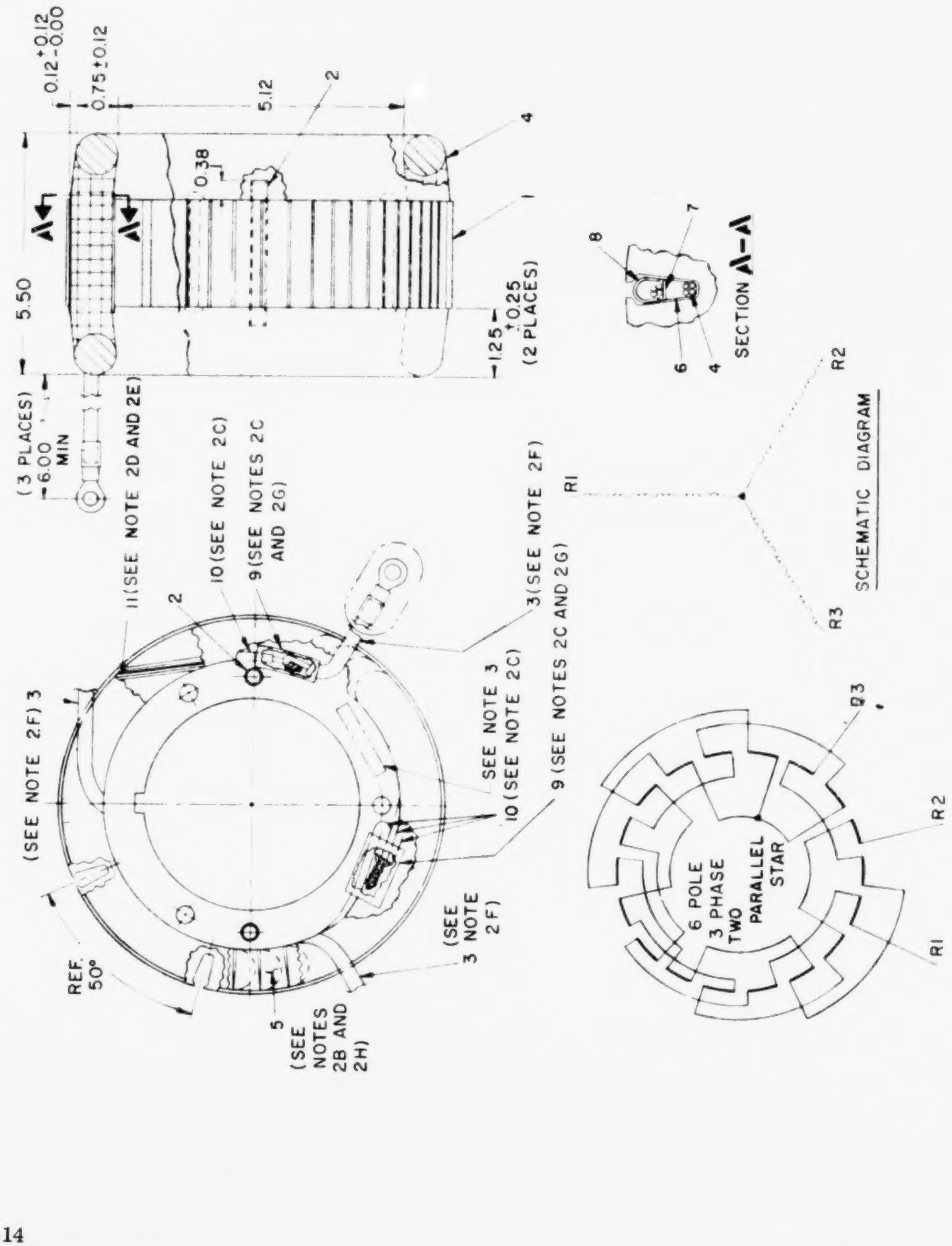

0.12 +0.12 -0.00
0.75±0.12
5.12
2
4
0.38
A
1
5.50
1.25 ±0.25 (2 PLACES)
(3 PLACES) 6.00 MIN
11 (SEE NOTE 2D AND 2E)
2
10 (SEE NOTE 2C)
9 (SEE NOTES 2C AND 2G)
3 (SEE NOTE 2F)
(SEE NOTE 2F) 3
SEE NOTE 3
10 (SEE NOTE 2C)
9 (SEE NOTES 2C AND 2G)
10
(SEE 3 NOTE 2F)
REF. 50°
5 (SEE NOTES 2B AND 2H)
8
7
6
4
SECTION A-A
R1
R2
R3
SCHEMATIC DIAGRAM
6 POLE 3 PHASE TWO PARALLEL STAR
R1
R2
R3

Figure 7-4. Generator, exciter rotor rewind data (sheet 1 of 2)

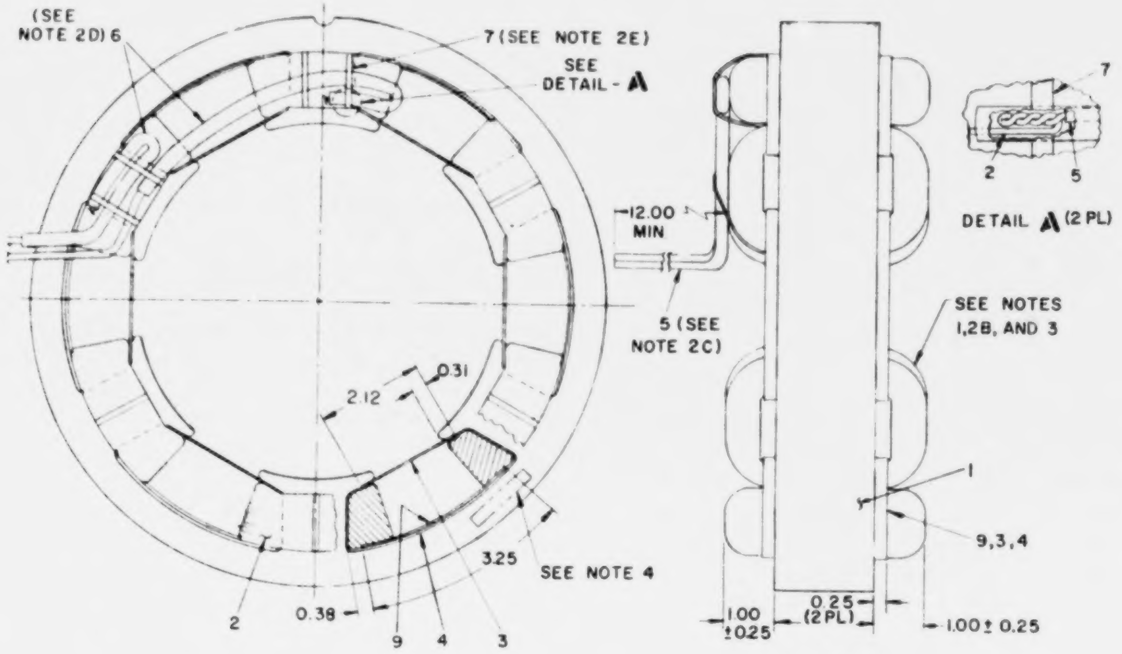
NOTES:

1. COIL DATA:
    - A. WIRE SIZE: 0.036 DIA (#19 GA) CLASS 155, TYPE L2.
    - B. NUMBER OF WIRES PER TURN: 5
    - C. NUMBER OF TURNS PER COIL: 5
    - D. NUMBER OF WIRES PER COIL: 25
    - E. COIL GROUPING: 18 GROUPS OF 2 COILS.
    - F. COIL SPAN: SLOTS 1 & 6.
2. ROTOR WINDING PROCEDURE:
    - A. WIND COILS TO PROPER SHAPE, SPECIFIED DIMENSIONS AND NUMBER OF TURNS.
    - B. HOLD COILS TOGETHER WITH TAPE, INDEX 6.
    - C. APPLY SLEEVING, INDEX NO. 10 AND INDEX 9 (LOOSE).
    - D. SELECT AN ARBITRARY SLOT ON CORE, INDEX 1, AND INSERT FIRST COIL GROUP WITH START LEAD IN THE BOTTOM OF SLOT NO. 1 AND THE ENDING LEAD IN THE TOP OF SLOT NO. 6. (COIL SPAN 1 & 6).
    - E. INSERT THE NEXT COIL GROUP PER ABOVE GROUPING SEQUENCE. INSERT PHASE INSULATION INDEX 11, DURING PLACING OF COILS. REPEAT SEQUENCE UNTIL WINDING IS COMPLETE.
    - F. MAKE PHASE CONNECTION AND CONNECT LEADS, INDEX 3 PER CONNECTION DIAGRAM. (HOMOGENEOUS WELD).
    - G. APPLY SLEEVING, INDEX 9, OVER LEADS, INDEX 3 CONNECTIONS AND PHASE CONNECTION.
    - H. WRAP WINDING WITH TAPE, INDEX 5.
    - J. VARNISH AS FOLLOWS:
        - STEP 1: PREBAKING -
          PUT INTO OVEN AT 110° C (230° F). HOLD AT TEMPERATURE FOR 4 HOURS. COOL TO APPROXIMATELY 50° C (122° F).
        - STEP 2: DIPPING -
          IMMERSE IN VARNISH, 70-4560, UNTIL BUBBLING CEASES. VISCOSITY SHALL BE HELD 20 ZAHN SECONDS USING A NO. 2 CUP. THIN WITH SOLVENT, P/N 70-4636 MAINTAIN VISCOSITY.
        - STEP 3: DRAINING -
          DRAIN AND AIR DRY FOR 1 HOUR. ROTATE WOUND APPARATUS TO PREVENT POCKETING THE VARNISH.
        - STEP 4. WIPING -
          AFTER DRAINING BUT BEFORE BAKING, THE METAL SURFACES OF THE ARMATURE, THE BORE OF THE ROTOR AND THE POLE FACES SHALL BE WIPED WITH A CLOTH MOISTENED WITH SOLVENT, P/N 70-4636.
        - STEP 5: BAKING -
          PUT INTO A CIRCULATING TYPE, FORCED EXHAUST, BAKING OVEN AT TEMPERATURE OF 80° C (176° F) FOR 3 HOURS. INCREASE TEMPERATURE TO 165° C (329° F) AND CONTINUE TO BAKE AN ADDITIONAL 7 HOURS.
        - STEP 6: COOLING -
          REMOVE FROM OVEN AND COOL TO APPROXIMATELY 50° C (122° F).
        - STEP 7: SECOND TREATMENT (DIP IN OPPOSITE DIRECTION) – REPEAT STEPS 2 (IMMERSE FOR 1 MINUTE), 3, 4, 5, AND 6.
        - STEP 8: THIRD TREATMENT (DIP IN ORIGINAL DIRECTION) - REPEAT STEPS 2 (IMMERSE FOR 1 MINUTE 3, 4, 5, AND 6.
3. STAMP PART NUMBER AS SHOWN BELOW PER MIL-STD-130, 0.12 MIN HEIGHT, USING WHITE ENAMEL PAINT.
   30554 ASSY 70-4519
   MFG (ADD MFG CODE)
4. AFTER REWINDING, PREFORM INSPECTION SPECIFIED IN PARAGRAPH 7-5, STEPS M AND Q.

Figure 7-4. Generator, exciter rotor rewind data (sheet 2 of 2)

Legend to figure 7-4:

1. Rotor core
2. Insulation (2)
3. Lead (3)
4. Magnet wire 0.040 DIA (#18)
5. Untreated glass tape 0.010 x 0.75
6. Slot cell insulation (36)
7. Center spacer 0.32 THK
8. Wedge (36)
9. Insulation sleeving 0.330 ID
11. Wire marker
10. Insulation sleeving 0.106 ID
11. Phase insulation
12. Varnish


(SEE NOTE 2D) 6
7 (SEE NOTE 2E)
SEE DETAIL - A
7
2
5
DETAIL A (2 PL)
12.00 MIN
5 (SEE NOTE 2C)
SEE NOTES 1,2B, AND 3
0.31
2.12
1
9,3,4
3.25
SEE NOTE 4
2
0.38
9
4
3
1.00 ±0.25
0.25 (2 PL)
1.00 ± 0.25

NOTES:

1. COIL DATA:
   - A. WIRE SIZE: 0.057 DIA (#15GA), CLASS 155, TYPE L2.
   - B. NUMBER OF POLES: 6
   - C. NUMBER OF TURNS PER COIL: 85
2. STATOR WINDING PROCEDURE:
   - A. INSULATE STATOR CORE, INDEX 1, COMPLETE USING INSULATION PLATE, INDEX 3, AND SLOT CELL INSULATION, INDEX 4 AND INDEX 9.
   - B. WIND STATOR COMPLETE, 6 COILS CONNECTED IN SERIES.
   - C. CONNECT LEADS, INDEX 5, TO COILS, SEE DETAIL A, HOMOGENOUS WELD.
   - D. APPLY SLEEVING, INDEX 6.
   - E. TIE LEADS AND ENDLOOPS WITH TAPE, INDEX 7.
3. VARNISH, REFER TO FIGURE 7-2 NOTE 3.
4. STAMP PART NUMBER AS SHOWN BELOW PER MIL-STD-130, 0.12 MIN HEIGHT, USING WHITE ENAMEL PAINT
   30554 ASSY 70-4522
   MFG (MFG CODE)
5. AFTER REWINDING, PERFORM INSPECTION SPECIFIED IN PARAGRAPH 7-5, STEPS N AND R.

Figure 7-5. Generator, exciter stator rewind data

Legend to figure 7-5:

1. Stator core
2. Magnet wire
   0.057 DIA (#15)
3. Insulation plate (6)
4. Slot cell insulation (6)
5. Lead (2)
6. Insulation sleeving
   0.330 ID
7. Untreated glass tape
   0.010 x 0.75
8. Varnish
9. Slot cell insulation (6)

Table 7-1. Generator Output Lead Lengths

| LEAD NUMBER | LEAD LENGTH IN INCHES (TOLERANCE $^{+0.005\ (.127\text{mm})}_{-0.0}$) |
|---|---|
| T1 | 42 (1066.8 mm) |
| T2 | 51 (1295.4 mm) |
| T3 | 48 (1219.2 mm) |
| T4 | 22 (558.8 mm) |
| T5 | 26.50 (673.1 mm) |
| T6 | 36 (914.4 mm) |
| T7 | 42 (1066.8 mm) |
| T8 | 51 (1295.4 mm) |
| T9 | 48 (1219.2 mm) |
| T10 | 22 (558.8 mm) |
| T11 | 26.50 (673.1 mm) |
| T12 | 36 (914.4mm) |

and install generator output leads (85) starting at generator top: T1, T6, and T7. Install clamp (81) and tighten nuts (78).

i. Insert exciter stator assembly (69) leads in connector (65) opening. Install exciter stator assembly into end bell (70), pulling leads through opening as exciter stator is installed. Cut exciter stator assembly leads to permit connection to connector (65), when connector is approximately one inch from end bell (70). Strip lead insulation back approximately 0.375 inch (9.525 mm) and solder lead F1 to connector pin C and lead F2 to connector pin B. Install connector (65) with key on top.

j. Install end bell and exciter stator assembly (62) on main stator and frame assembly (44) with connector (65) positioned at three o'clock looking from rear of generator.

k. Install key (39) on shaft (43) and using a suitable press, press shaft (43) into main rotor subassembly (38) until main rotor subassembly (38) is against shoulder on shaft (43).

l. Install key (37) on shaft (43). Heat hub (36) in a suitable oven to 450°F (232.2°C) and install hub (36) on shaft (43) until it bottoms on shaft shoulder.

m. Install key (35) and exciter rotor assembly (34) on shaft (43). Using a suitable press, press spacer (32) into place.

n. Assemble rectifier assembly (12) and position on shaft (43). Align setscrew (11) hole with hole in shaft (43).

o. Install setscrews (11 and 31) and tighten to 20 foot-pounds (2.766 meters) torque.

p. Apply insulation sleeving to main rotor subassembly (38) leads R4 and R5. Position lead R5 at three o'clock and lead R4 at nine o'clock on shaft (43) looking from bearing end of shaft. Tape leads to shaft at two evenly spaced positions between the main rotor subassembly (38) and exciter rotor assembly (34). Brush coat tape with varnish. Position leads R4 and R5 through two holes provided in exciter rotor assembly (34) and insulator (30). Cut leads long enough to connect a rectifier assembly (12). Strip lead insulation back 0.375 (9.525 mm) inch and install terminal lugs on leads. Connect leads R4 and R5 to rectifier assembly.

q. Position leads R1, R2, and R3 from exciter rotor assembly (34) through insulator (30) holes and cut leads long enough to connect to rectifier assembly (12). Strip lead insulation back 0.375 inch (9.525 mm) and install.

terminal lugs and connect leads R1, R2, and R3 to rectifier assembly (12).

r. Using a suitable press, press bearing (8) against shoulder on shaft (43). Install snap ring (7) on shaft (43).

s. Place assembled shaft in a suitable dynamic balancing machine. Balance assembled shaft in two planes. Rotate shaft at 600 to 800 RPM and balance shaft to 4 inch-ounce using balance weights (41). To install balance weight, place weight in proper position on rotor and transfer drill two 0.2570 inch (6.528 mm) holes, one inch deep for each weight. Tap hole for 5/16 - 18 UNC - 2B thread. Secure weights with screws (40) and lock washers (41). Trim balance to 0.5 inch-ounce by removing metal from steel core of main rotor subassembly (38).

t. Place rotor and shaft assembly (1) on a bench resting main rotor subassembly (38) on a cushion material to prevent damage. Allow hub (36) hang over side of bench.

NOTE

Securing fan to shaft couplings is only to protect fan from damage and for ease of handling.

u. Position fan (6) on shaft couplings (5) and secure fan to shaft couplings with two suitable screws and nuts 180 degrees apart. Install fan (6), shaft couplings (5), retainer (4), and clip locks (3) on shaft (43) and secure with screws (2), leaving two screws (2) 180 degrees apart out. Tighten screws to 50 foot-pounds torque. Insert two suitable lifting eyebolts into shaft hub.

v. Using a suitable lifting device and cable hook, position main stator and frame assembly (44) in a vertical position resting the end bell (70) on wooden blocks. Place blocks under the generator mounting plates to prevent generator from tipping over.

CAUTION

Exercise extreme care when installing main rotor and shaft assembly into main stator and frame assembly to prevent damage to windings.

w. Connect suitable lifting device to lifting eyebolts on main rotor and shaft assembly (1), and install into main stator and frame assembly (44). Remove lifting device and lifting eyebolts. Install two remaining screws (2) and tighten screws from 45 to 50 foot-pounds (6.223 to 6.915 kg-meters) torque. Bend up all corners of clip locks (3) to prevent screws from turning.

x. Connect a suitable block across engine mounting end of generator to hold main rotor and shaft assembly in center position and to prevent assembly from sliding out of frame when moving generator.

y. Lower generator to horizontal position. Place tag on generator stating fan is mounted to shaft coupling with shipping screws and nuts only. Remove screws and nuts prior to installation.

## 7-8. HIGH POTENTIAL TEST.

Perform the high potential test as follows:

CAUTION

This test is applicable to new or rewound components only.

NOTE

The generator and exciter armature and field windings are connected in series.

a. Isolate the generator and exciter armature and field windings from all external circuits including rotating rectifiers. Be sure generator frame and test apparatus are properly grounded to an external ground (in addition to unit frame). Connect one end of each armature winding together to form a single circuit for testing.

CAUTION

Ground generator and exciter field windings securely when testing generator armature windings.

b. Connect the high voltage lead from the test apparatus to the generator armature winding. Bring the voltage up to 1480 volts in not less than 10 seconds nor more than 30 seconds. Apply this voltage for one minute then gradually reduce to zero in not less than 5 seconds. Ground high voltage lead before removing to discharge winding.

CAUTION

Ground generator armature and exciter windings securely when testing generator field windings. Ground generator field and generator armature windings securely when testing exciter windings.

c. Repeat step b. for the generator field and exciter windings, except that the maximum voltage shall be between 1500 to 3500 volts.

d. Electrical windings shall be able to withstand the following 60 hertz voltages applied for one minute between the windings and ground.

Generator armature windings - 1480 volts
Generator field and exciter windings - 1500 to 3500 volts

## 7-9. INSTALLATION.

Install the generator as specified in paragraph 2-7.

# CHAPTER 8

# ENGINE GROUP REPAIR INSTRUCTIONS

## Section I. ENGINE COMPONENTS

### 8-1. GENERAL.

The engine is a six cylinder, 4 cycle, turbo charged, overhead valve diesel. Components covered in this chapter, in addition to the basic engine, are those which are mounted on the engine block.

### 8-2. REMOVAL.

Refer to paragraph 2-8 and remove the engine group.

### 8-3. DISASSEMBLY.

a. Tag and remove all hydraulic and fuel lines from engine. Cap lines and plug all openings.

b. Refer to Operator and Organizational Maintenance Manual and remove the following.

1. Alternator and fan drive belts
2. Alternator assembly
3. Fuel day tank
4. Manual speed controls
5. Fuel filter and pump assembly, threaded spacers and adapter.
6. Starter motor
7. Lubricating oil filters
8. Secondary fuel filter and relief valve
9. Breather assembly
10. Hydraulic filter (precise sets only)
11. Atomizer tube, atomizer and bushing.

c. Remove oil pan shutoff cock.

d. Remove three screws and lockwashers securing two flywheel housing supports.

e. Remove components and disassemble engine as specified in subsequent sections of this chapter.

### 8-4. REASSEMBLY.

a. Replace components and reassemble engine as specified in subsequent sections of this chapter.

b. Install two flywheel housing supports and secure with four screws and lockwashers.

c. Install oil pan shutoff cock.

d. Refer to Operator and Organizational Maintenance Manual and install the following.

1. Atomizer tube, atomizer and bushing.

2. Hydraulic filter (precise sets only).

3. Breather assembly.

4. Secondary fuel filter and relief valve.

5. Lubricating oil filters.

6. Starter motor.

7. Fuel filter and pump assembly, threaded spacers and adapter.

8. Manual speed controls.

9. Fuel day tank

10. Alternator assembly.

11. Alternator and fan drive belts.

e. Connect all hydraulic and fuel lines to engine.

f. Refer to Operator and Organizational Maintenance Manual and adjust fan and alternator belts, valve lash, and utility governor linkage. Service the engine and components.

### 8-5. INSTALLATION.

NOTE

> If a complete overhaul or any major repair has been performed on the engine, refer to Section XXXI for engine test after overhaul.

Refer to paragraph 2-8 and install the engine group.

## Section II. ENGINE HARNESS GROUP

### 8-6. GENERAL.

The engine wiring harness provides for electrical interconnection between the engine accessories and mode I relay box. The harness is connected to connector J5 of the mode I relay box (A27), J14 of high coolant temperature switch, J33 of day tank float switch, J35 of air cleaner indicator switch, J36 of tank solenoid valve, J37 of speed switch, J38 of ether starting aid primer, J39 of DC control circuit breaker, J42 of low oil pressure switch, J43 of alternator, two oil pressure transmitters, collant temperature transmitter, fuel level transmitter, fuel transfer pumps, engine shutdown solenoid valve, starter, and starter solenoid.

### 8-7. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove the engine wiring harness.

### 8-8. CLEANING.

a. Clean wires with a clean lint free cloth.

b. Remove dirt from connector pins using low pressure compressed air.

### 8-9. INSPECTION.

a. Inspect wiring for defective insulation, continuity, and proper connection.

b. Inspect electrical connectors for damaged threads; bent, loose, or missing pins; and for shorts to case and surrounding pins.

c. Inspect terminal lugs for security and condition.

d. Check each wire for continuity, refer to figure 8-1.

## 8-10. REBUILD.

Refer to figure 8-1 and rebuild engine wiring harness.

## 8-11. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install the engine wire harness.

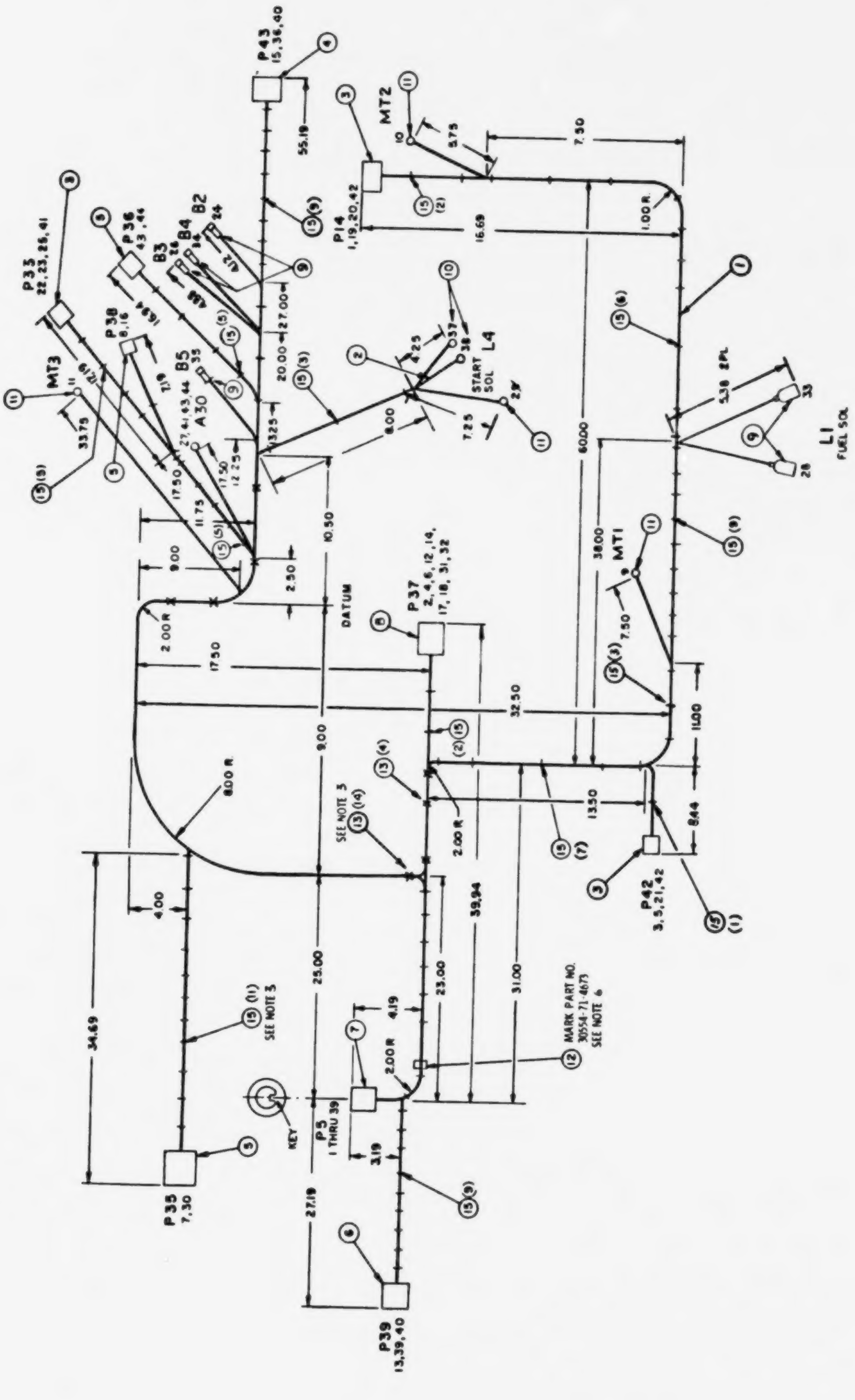

P43
15,36,40
55.18
P14
1,19,20,42
MT2
10
5.75
7.50
16.69
1.00 R
P33
22,23,28,41
P36
43,44
B3
B4
B2
P38
8,16
MT3
33.75
B5
A30
27.00
20.00
13.25
10.50
L4
START SOL
8.00
7.25
4.25
60.00
5.38 2PL
L1
FUEL SOL
MT1
7.50
38.00
17.50
11.75
9.00
2.50
2.00 R
DATUM
P37
2,4,6,12,14,
17,18,31,32
32.50
11.00
9.00
8.00 R
SEE NOTE 3
2.00 R
13.50
8.44
P42
3,5,21,42
34.69
4.00
25.00
23.00
39.94
31.00
4.19
MARK PART NO.
30554-71-4673
SEE NOTE 6
2.00 R
SEE NOTE 3
KEY
P5
1 THRU 39
3.19
27.19
P35
7,30
P39
13,39,40

Figure 8-1. Engine wire harness (sheet 1 of 2)

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMIN FIND NO. | TO | TERMIN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | RED | P207C16 | P5-A | 7 | P14-B | 3 | 121.50 |
| 2 | RED | P202C16 | P5-B | | P37-J | 8 | 43.00 |
| 3 | RED | P201C16 | P5-C | | P42-D | 3 | 53.00 |
| 4 | RED | P44J16 | P5-D | | P37-A | 8 | 43.00 |
| 5 | RED | P58A16 | P5-E | | P42-C | 3 | 54.00 |
| 6 | RED | P81E16 | P5-F | | P37-D | 8 | 43.00 |
| 7 | RED | P198D16 | P5-G | | P35-A | 5 | 80.00 |
| 8 | RED | P46D16 | P5-H | | P38-A | 5 | 94.00 |
| 9 | RED | E39D16 | P5-I | | MT1 | 11 | 67.00 |
| 10 | RED | E38D16 | P5-J | | MT2 | 11 | 123.50 |
| 11 | RED | E37D16 | P5-K | | MT3 | 11 | 100.00 |
| 12 | RED | P140K16 | P5-L | | P37-E | 8 | 43.00 |
| 13 | RED | P40F16 | P5-M | | P39-A | 6 | 29.00 |
| 14 | RED | P80H16 | P5-P | | P37-H | 8 | 43.00 |
| 15 | RED | P80J16 | P5-R | | P43-A | 4 | 120.00 |
| 16 | RED | P55H16 | P5-S | | P38-B | 5 | 91.50 |
| 17 | RED | P48A16 | P5-U | | P37-B | 8 | 43.00 |
| 18 | RED | P54A16 | P5-V | | P37-C | 8 | 43.00 |
| 19 | RED | P200K16 | P5 W | | P14-C | 3 | 122.50 |
| 20 | RED | P52A16 | P5-Y | | P14-D | 3 | 125.00 |
| 21 | RED | P200M16 | P5-Z | | P42-A | 3 | 50.00 |
| 22 | RED | P68A16 | P5 b | | P33-D | 3 | 104.00 |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMIN FIND NO | TO | TERMIN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 23 | RED | P50Y16 | P5-c | | P33-C | 3 | 104.00 |
| 24 | RED | P51E16 | P5 d | | B2 | 9 | 110.00 |
| 25 | RED | P50W16 | P5-e | | P33-A | 3 | 105.00 |
| 26 | RED | P51H16 | P5-f | | B3 | 9 | 101.00 |
| 27 | RED | P55T16 | P5-g | | A30-3 | 16 | 118.00 |
| 28 | RED | P55P16 | P5-h | | L1-1 | 9 | 102.00 |
| 29 | RED | P41B16 | P5-j | | L4-1 | 11 | 101.00 |
| 30 | RED | P50LL16 | P5-k | | P35-B | 5 | 80.00 |
| 31 | RED | P200R16 | P5-m | | P37-F | 8 | 43.00 |
| 32 | RED | P47K16 | P5-n | | P37-G | 8 | 43.00 |
| 33 | RED | P80K16 | P5-p | | L1-2 | 9 | 98.00 |
| 34 | RED | P50SS16 | P5-r | | B4 | 9 | 103.00 |
| 35 | RED | P50UU16 | P5-s | | B5 | 9 | 95.00 |
| 36 | RED | P55N12 | P5-t | | P43-C | 4 | 119.50 |
| 37 | RED | P55D12 | P5-u | | B1 | 10 | 121.50 |
| 38 | RED | P140D12 | P5-w | | L4-3 | 10 | 97.50 |
| 39 | RED | P141B12 | P5-z | 7 | P39-C | 6 | 29.00 |
| 40 | RED | P141A12 | P43-B | 4 | P39-B | 6 | 144.00 |
| 41 | RED | P69A16 | P33-B | 3 | A30-1 | 16 | 51.00 |
| 42 | RED | P53A16 | P42-B | 3 | P14-A | 3 | 84.00 |
| 43 | RED | P55AX | A30-3 | 16 | P36B | 5 | 46.00 |
| 44 | RED | P69B16 | A30-2 | 16 | P36A | 5 | 46.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16 | | | MS25036-106 | 4 | TERMINAL, LUG, CRIMP STYLE | | |
| 15 | | | MS3367-4-9 | 92 | STRAP, TIEDOWN | | NYLON |
| 14 | | | SN60WRAP2 | AR | SOLDER, LEAD-TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 3 |
| 13 | | | MS3367-1-9 | 20 | STRAP, TIEDOWN | | NYLON |
| 12 | | | MS39020-4 | 1 | BAND, MARKER | | AL ALY |
| 11 | | | MS25036-108 | 4 | TERMINAL, LUG, CRIMP STYLE | | |
| 10 | | | MS25036-158 | 2 | TERMINAL, LUG, CRIMP STYLE | | |
| 9 | | | MS27144-2 | 6 | CONNECTOR ASSEMBLY, MALE | | |
| 8 | | | MS3106R18-1S | 1 | CONNECTOR, PLUG | | |
| 7 | | | MS3106R36-7S | 1 | CONNECTOR, PLUG | | |
| 6 | | | MS3106R16-10S | 1 | CONNECTOR, PLUG | | |
| 5 | | | MS3106R10SL-4S | 3 | CONNECTOR, PLUG | | |
| 4 | | | MS3106R18-5P | 1 | CONNECTOR, PLUG | | |
| 3 | | | MS3106R14S-2S | 3 | CONNECTOR, PLUG | | |
| 2 | | | M5086/2-12-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 14
3. CABLE STRAPS, FIND NO. 13 AND 15, SHALL BE SPACED AT APPROX. 3.00 APART
4. UNLESS OTHERWISE SPECIFIED.
   WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088
   EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. A. TRUNK BENDS TO BE 2.00 RADIUS EXCEPT WHERE OTHERWISE SPECIFIED.
   B. BREAKOUTS TO BE 1.00 RADIUS.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

Figure 8-1. Engine wire harness (sheet 2 of 2)

## Section III. ALTERNATOR

### 8-12. GENERAL.

The alternator is a 24 volt, negative ground system incorporating a voltage regulator and voltage protector. It is driven by the fan pulley via the alternator drive belt. The alternator provides power for charging the batteries and operation of direct current components of the generator set.

### 8-13. REMOVAL.

Refer to Operator and Organizational Maintenance Manual, and remove the alternator.

### 8-14. DISASSEMBLY.

Refer to figure 8-2, and disassemble alternator in the order of index numbers assigned. Pay particular attention to the following:

NOTE

Tag electrical leads before removing to facilitate reassembly.

CAUTION

When removing brush assembly (29) pull out and up to prevent damage.

CAUTION

To prevent damage to stator windings or laminations, do not insert sharp tools between stator and housing.

a. When removing front and rear bearings (47 and 51) from rotor assembly shaft (49), make sure puller contacts inner bearing race only.

NOTE

Remove retaining ring in front housing . Refer to figure 8-2 view A and B.

CAUTION

To prevent overheating and possible damage to rectifier diodes (37 and 38) when unsoldering, grasp diode connection terminal with long nose pliers, between soldering iron and diode.

b. To prevent rotor shaft assembly (49 from turning when removing nut (40), wrap an oversize belt around pulley. Clamp pulley in vise while removing rotor shaft from pulley.

### 8-15. CLEANING.

CAUTION

Do not immerse alternator assembly in cleaning solvent of any kind. Do not clean isolation diodes (22) with cleaning solvent. The diodes are coated with a special corrosion resistant paint.

WARNING

Dry cleaning solvent, P-D-680, Type II is flammable and moderately toxic to the skin, eyes and respiratory tract. Skin, eye and respiratory protection is required.

a. Clean parts with a soft bristle brush moistened with cleaning solvent, Federal Specification, P-D-680, Type II.

b. Dry parts with filtered low pressured compressed air or a clean lint-free cloth.

## 8-16. INSPECTION.

a. Inspect brush assembly (29, figure 8-2) for excessive wear, replace brush assembly if 3/16 of an inch or less extends beyond bottom of holder.

b. Check brush assembly (29) spring tension with suitable spring scale. Spring tension should be 4 to 6 ounces.

c. Test rectifier diodes (37 and 38) in heat sinks connecting one of multimeter leads to the heat sink and the other multimeter lead to the diode stem, and note the reading. Then reverse the multimeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading.

d. Test isolation diode assembly (22) by connecting one of the multimeter test leads to the output terminal stud of the diode, the other to the exposed metal area on heat sink, and note reading. Then reverse the lead connections and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading.

e. Test stator assembly (39) for grounds and opens as follows:

NOTE

> These tests may be made with the stator leads disconnected from the diodes, or with the stator leads connected to the diodes provided all the diodes are in good condition. Scrape enough insulation from the leads to insure good contact with the test prods.

1. Connect the multimeter to two pairs of stator leads. Use a multimeter and set to the lowest range scale on the multimeter. If either reading is very high (infinite) the stator winding is open.

2. To test the stator for grounds, connect the multimeter from any stator lead to the ground screw or the shell, and note the reading. Then reverse the multimeter lead connections, and note the reading. If both readings are very low, the stator is grounded.

f. Test rotor assembly (51) or grounded slip ring, using a multimeter. No circuit from either slip ring to shaft is correct condition.

g. Perform resistance check on rotor assembly (51) windings using a multimeter. Resistance should be between 11 to 14 ohms.

h. Test voltage regulator (25) by connecting multimeter leads to regulator leads as follows: (See figure 8-3).

1. Multimeter lead (+) to regulator lead yellow, multimeter lead (-) to regulator lead red. Multimeter should indicate 300 to 350 ohms.

2. Multimeter lead (+) to regulator lead red, multimeter lead (-) to regulator lead yellow, multimeter should indicate open circuit.

3. If above readings are not obtained, replace regulator.

i. Inspect fan (43) for cracked or broken fins. Check fan bore for wear.

j. Inspect pulley (42) for worn drive surfaces and condition of key groove. Check pulley bore for wear.

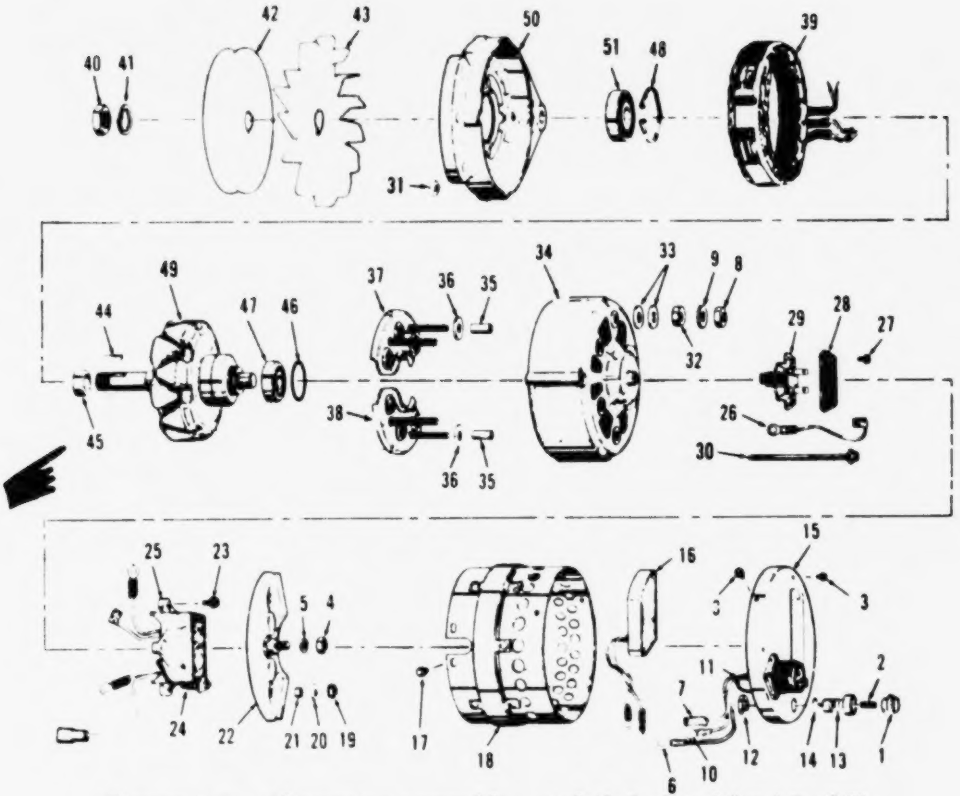

42
43
50
39
40
41
51
48
31
49
37
36
35
34
33
9
8
44
47
46
29
28
27
32
45
38
26
36
35
30
15
25
23
16
5
4
3
3
11
2
7
24
22
21
20
19
17
18
12
14
13
1
6
10

Figure 8-2. Alternator assembly, exploded view (sheet 1 of 2)

1. Cap
2. Fuse (40 amp)
3. Screw (5)
4. Nut
5. Washer
6. Connector (red)
7. Connector (yellow)
8. Nut (2)
9. Washer (2)
10. Connector (black)
11. Connector (black)
12. Nut
13. Receptacle
14. Gasket
15. Cover and connector assembly
16. Circuit protector
17. Screw (8)
18. Housing shield assembly
19. Nut (2)
20. Washer (2)
21. Sleeve (2)
22. Isolation diode assembly
23. Screw (3)
24. Voltage adjust rheostat
25. Voltage regulator
26. Cable
27. Screw (2)
28. Cover
29. Brush assembly
30. Bolt (4)
31. Nut (4)
32. Nut (4)
33. Washer (8)
34. Rear housing
35. Sleeve (4)
36. Washer (4)
37. Rectifier diode assembly (positive)
38. Rectifier diode assembly (negative)
39. Stator assembly
40. Nut
41. Lock washer
42. Pulley
43. Fan
44. Key
45. Spacer
46. Retaining ring
47. Rear bearing
48. Retaining ring
49. Rotor assembly
50. Front bearing
51. Front bearing

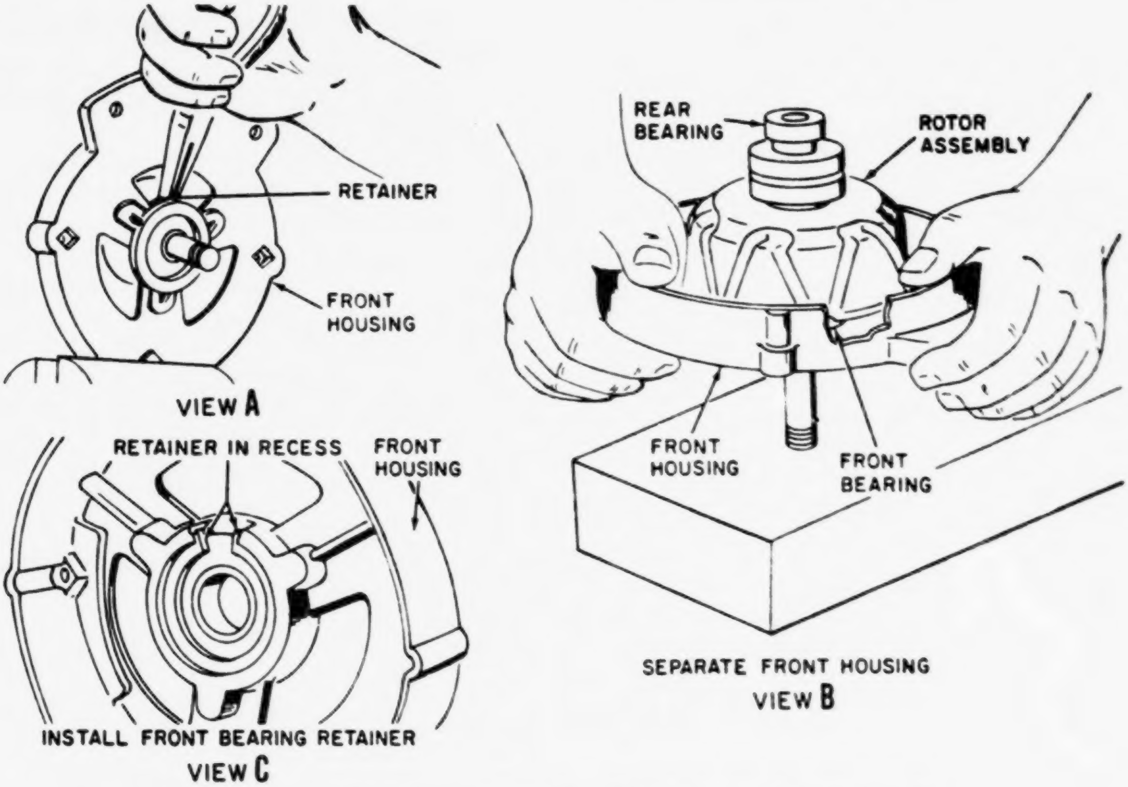

RETAINER
FRONT HOUSING
VIEW A
REAR BEARING
ROTOR ASSEMBLY
FRONT HOUSING
FRONT BEARING
SEPARATE FRONT HOUSING
VIEW B
RETAINER IN RECESS
FRONT HOUSING
INSTALL FRONT BEARING RETAINER
VIEW C

Figure 8-2. Alternator assembly, exploded view (sheet 2 of 2)

k. Inspect front bearing cavity for evidence of wear. Check condition of retainer recess.

l. Check slip rings for pitting, roughness or burned spots. If surface is worn beyond repair, replace entire rotor assembly (49).

m. Inspect rotor shaft for key slot wear, worn bearing surfaces, scuff marks on pole fingers, and condition of threads on pulley nut.

n. Inspect bearings (47 and 51) for scored, pitted, scratched, cracked or chipped races.

### 8-17. REPAIR.

CAUTION

Do not attempt to turn slip ring in a lathe.

a. Slip rings may be cleaned up by cleaning contacting surfaces with a fine crocus cloth. Carefully wipe dust and residue away after cleaning.

b. Repair minor thread damage on rotor shaft using a suitable thread chaser.

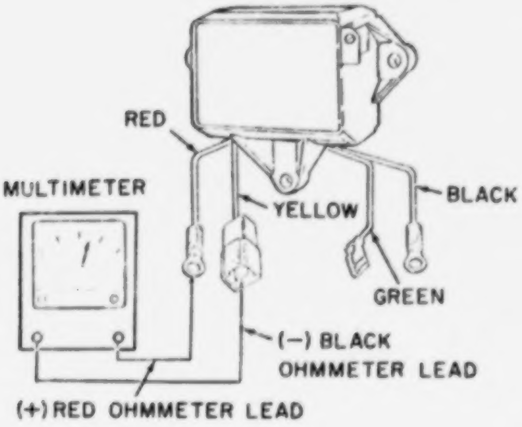


Figure 8-3. Voltage regulator excitation circuit test

## 8-18. REASSEMBLY.

Refer to figure 8-2 and reassemble alternator in the reverse order of index numbers assigned. Pay particular attention to the following:

NOTE

Refer to schematic wiring diagram figure 8-4 when connecting electrical leads.

CAUTION

**To prevent overheating and possible damage to rectifier (37 and 38) diodes when soldering, grasp diode connection terminal with long nose pliers between soldering iron and diode.**

**a. When installing rear and front bearings (47 and 51) on shaft, use hollow sleeve the same diameter of inner races and press bearings on rotor assembly shaft (49). Install front bearing retainer (48, VIEW c).**

**b. Tighten through bolts (30) evenly.**

**c. Spin rotor by hand and check freedom of rotation.**

**d. Tighten pulley nut (40) from 35 to 50 foot pounds torque.**

## 8-19. TEST AND ADJUSTMENT.

a. Voltage Regulator Setting Test.

1. Equipment required

(a) Variable speed drive (2000 to 3000 RPM).

(b) Resistor (1/4 ohm 500 watt).

(c) DC voltmeter (0 to 50 volt scale).

(d) Two 12 volt batteries.

(e) Jumper 12 inches long, No. 8 wire with two alligator clips.

(f) Mating plug for alternator receptacle, to be wired as shown in figure 8-4.

2. Connect circuit as shown in figure 8-5.

CAUTION

**Alternator must be driven in direction of arrow on rear cover (15, figure 8-2).**

**3. Connect alternator to variable speed drive by means of a suitable belt and pulley combination.**

**4. Run alternator up to a speed between 2000 to 3000 RPM. Connect jumper wire across 1/4 ohm resistor. Run alternator under these conditions for a warm up period of at least 10 minutes.**

5. Remove jumper from across 1/4 ohm resistor and record voltage reading. Nominal voltage should be 28 ± 3 volts at 75°F (24°C) ambient. If nominal voltage is not indicated, adjust voltage adjust rheostat (24, figure 8-2) on voltage regulator, which is accessible through rear cover (15) of alternator. Increase voltage by rotating in a clockwise direction.

6. If nominal voltage can not be obtained, shut down alternator test. Replace voltage regulator and repeat test.

b. Alternator Output Test.

1. Equipment required in addition to equipment listed in step a.

(a) Carbon pile (0 to 600 ampere load capacity).

(b) Ammeter (0 to 50 ampere scale).

(c) Jumper lead and 1/4 ohm resistor not used in this test.

2. Connect circuit as shown in figure 8-6.

CAUTION

Alternator must be driven in direction of arrow (shown on rear cover 15, figure 8-2).

NOTE

Make sure drive belt has a midway deflection of 9/16 to 13/16 of an inch (14.288 to 20.638 mm).

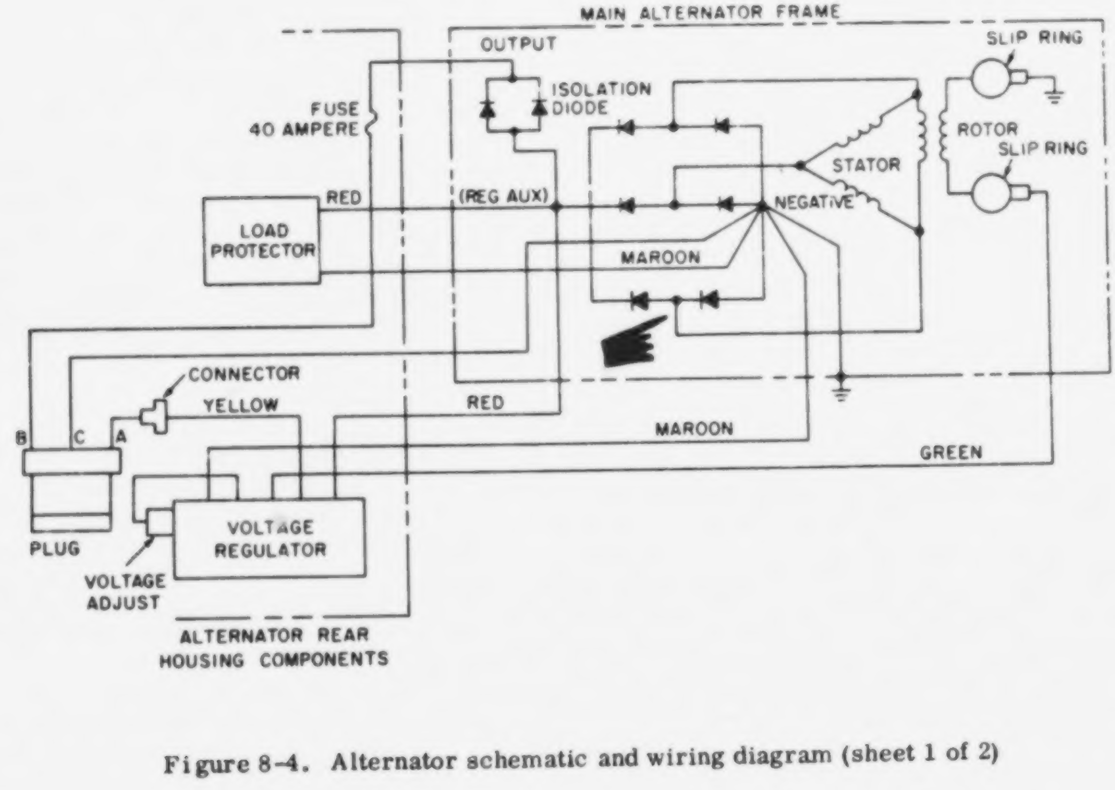
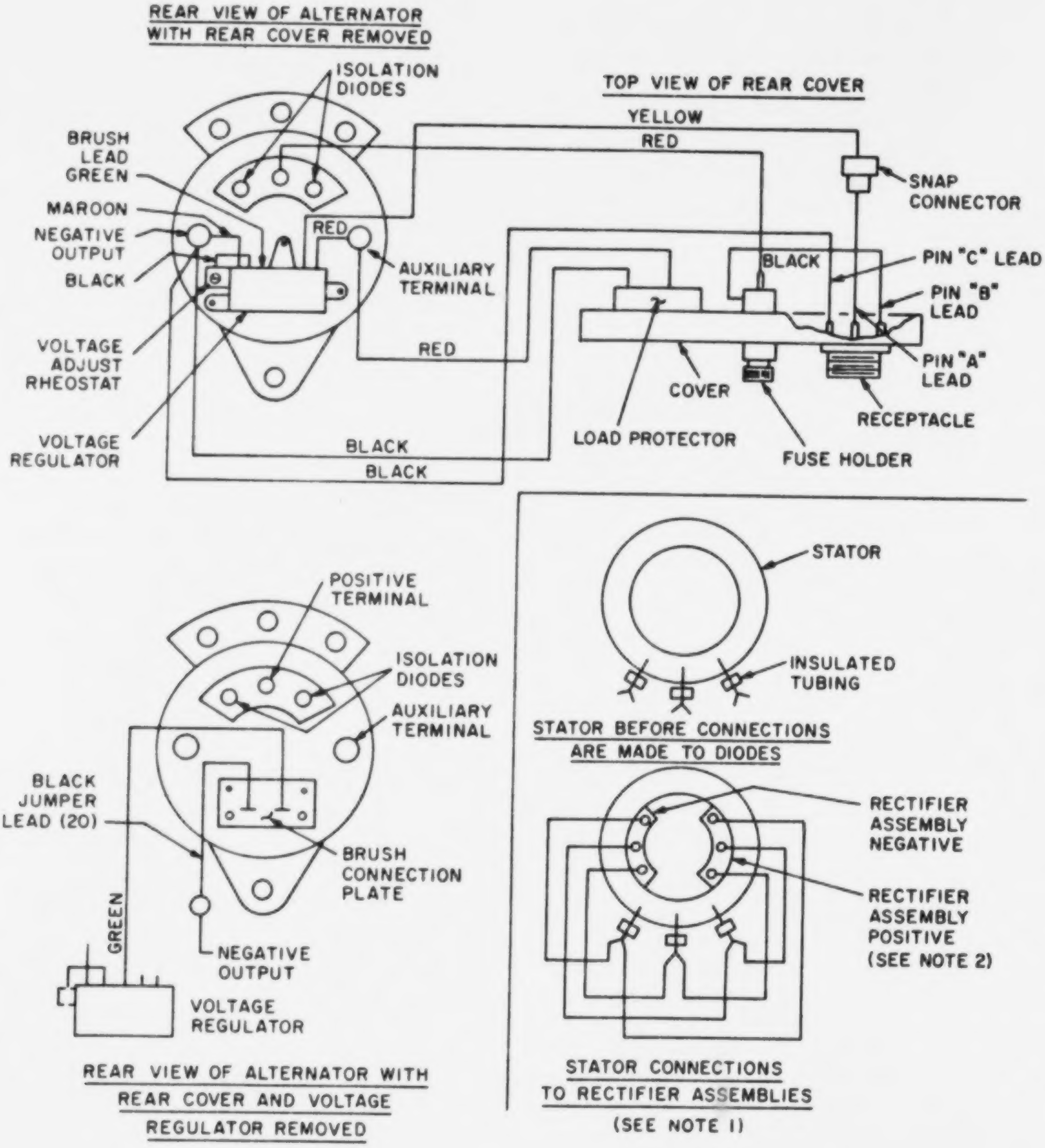

MAIN ALTERNATOR FRAME
OUTPUT
ISOLATION DIODE
SLIP RING
ROTOR
SLIP RING
FUSE 40 AMPERE
STATOR
RED
(REG AUX)
NEGATIVE
LOAD PROTECTOR
MAROON
CONNECTOR
YELLOW
RED
B
C
A
MAROON
GREEN
PLUG
VOLTAGE REGULATOR
VOLTAGE ADJUST
ALTERNATOR REAR HOUSING COMPONENTS

Figure 8-4. Alternator schematic and wiring diagram (sheet 1 of 2)


REAR VIEW OF ALTERNATOR WITH REAR COVER REMOVED
ISOLATION DIODES
BRUSH LEAD GREEN
MAROON
NEGATIVE OUTPUT
BLACK
VOLTAGE ADJUST RHEOSTAT
VOLTAGE REGULATOR
RED
AUXILIARY TERMINAL
RED
BLACK
BLACK
TOP VIEW OF REAR COVER
YELLOW
RED
SNAP CONNECTOR
BLACK
PIN "C" LEAD
PIN "B" LEAD
PIN "A" LEAD
COVER
RECEPTACLE
LOAD PROTECTOR
FUSE HOLDER
POSITIVE TERMINAL
ISOLATION DIODES
AUXILIARY TERMINAL
BLACK JUMPER LEAD (20)
BRUSH CONNECTION PLATE
GREEN
NEGATIVE OUTPUT
VOLTAGE REGULATOR
REAR VIEW OF ALTERNATOR WITH REAR COVER AND VOLTAGE REGULATOR REMOVED
STATOR
INSULATED TUBING
STATOR BEFORE CONNECTIONS ARE MADE TO DIODES
RECTIFIER ASSEMBLY NEGATIVE
RECTIFIER ASSEMBLY POSITIVE (SEE NOTE 2)
STATOR CONNECTIONS TO RECTIFIER ASSEMBLIES
(SEE NOTE 1)

NOTE:

1. THESE TWO LEADS MAY BE CONNECTED TO ANY DIODE ON A RECTIFIER ASSEMBLY PROVIDING ONE DIODE IS ON THE POSITIVE HEATSINK AND THE OTHER DIODE IS ON THE NEGATIVE HEATSINK. THE SAME APPLIES TO THE OTHER TWO SETS OF LEADS.

2. POSITIVE RECTIFIER ASSEMBLY CAN BE IDENTIFIED BY RED LETTERING ON UNDERSIDE OF THE THREE DIODES.

Figure 8-4. Alternator schematic and wiring diagram (sheet 2 of 2)

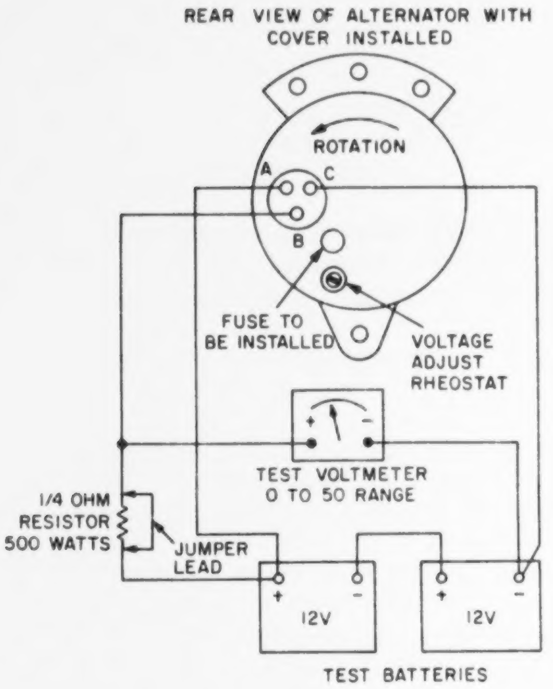

REAR VIEW OF ALTERNATOR WITH COVER INSTALLED
ROTATION
A
C
B
FUSE TO BE INSTALLED
VOLTAGE ADJUST RHEOSTAT
+
-
TEST VOLTMETER 0 TO 50 RANGE
1/4 OHM RESISTOR 500 WATTS
JUMPER LEAD
+
-
12V
+
-
12V
TEST BATTERIES

Figure 8-5. Voltage regulator setting test

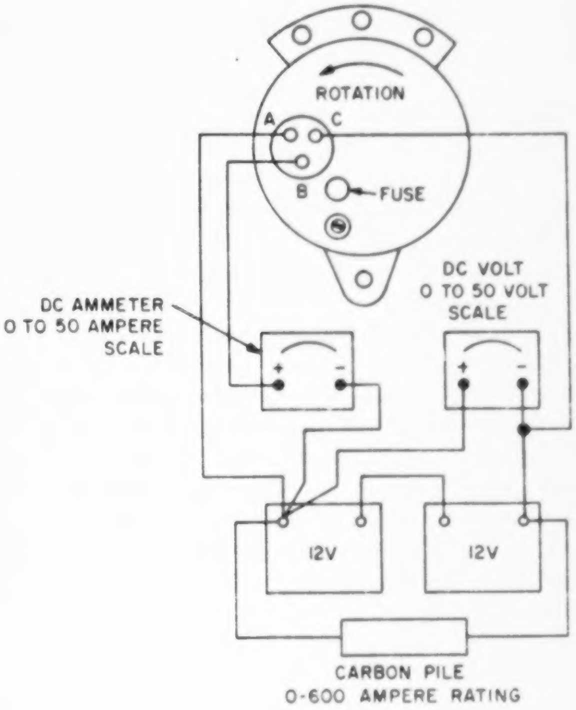

ROTATION
A
C
B
FUSE
DC AMMETER 0 TO 50 AMPERE SCALE
DC VOLT 0 TO 50 VOLT SCALE
+
-
+
-
12V
12V
CARBON PILE 0-600 AMPERE RATING

Figure 8-6. Alternator output test

3. Run alternator up to a speed of approximately 1500 RPM. Adjust carbon pile by slowly applying load across battery until test ammeter indicates a 10 ampere charging current. Allow alternator to run at this speed for at least 5 minutes to stabilize component temperatures.

4. Increase variable drive speed to 2500 RPM. Increase carbon pile load on battery causing alternator to deliver its maximum current capacity indicated on test ammeter.

5. Record maximum current obtained. Record voltmeter reading at maximum current condition.

6. Shut down alternator and disconnect carbon pile from across batteries immediately to prevent discharging batteries.

7. Nominal output current should be 20 to 25 amperes at 75°F ambient. This current output of 20 to 25 amperes should be obtained with test voltmeter indicating 26 to 30 volts.

8. If nominal current of 20 to 25 amperes can not be obtained, check drive belt for proper tension. If drive belt has a midway deflection of 9/16 to 13/16 of an inch, then disassemble alternator and inspect (para 8-16).

## 8-20. INSTALLATION

Refer to Operator and Organizational Maintenance Manual, and install the alternator.

## Section IV. STARTING MOTOR

### 8-21. GENERAL.

The starting motor is mounted to the flywheel housing. It consists of a frame and field assembly, armature head assembly, intermediate housing assembly, brush assembly starter drive, drive housing assembly, and a solenoid switch. The starting motor is a heavy-duty type that is completely sealed with gaskets, preformed packings and an oil seal. The solenoid is mounted on the outside of the frame with the solenoid plunger and pinion engagement mechanism totally enclosed. The starting motor converts electrical energy from the batteries into mechanical energy to turn the engine over for starting.

### 8-22. REMOVAL.

Refer to Operator and Organizational Maintenance Manual, and remove the starting motor.

### 8-23. DISASSEMBLY.

Refer to figure 8-7 and disassemble starting motor in the order of index numbers assigned. Pay particular attention to the following:

a. Before separating the lever housing (91) and drive housing (78), scribe or center punch locating marks to insure proper reassembly.

b. Bushings (26, 77, and 90) are press fitted.

c. Scribe or center punch locating mark before separating commutator end frame and frame on field coil assembly (95).

### 8-24. CLEANING.

#### CAUTION

To prevent damage to brushes, do not allow dry cleaning solvent to come in contact with brushes.

a. Clean brushes with a clean, dry cloth only.

b. Clean electrical components with a clean lint-free cloth moistened with an approved cleaning solvent and dry thoroughly.

c. Clean metal parts with a clean cloth moistened with an approved cleaning solvent and dry thoroughly.

#### CAUTION

Do not use emery cloth to clean commutator.

d. Remove loose particles from armature with compressed air and wipe with a clean lint-free cloth moistened with dry cleaning solvent. Clean commutator lightly with No. 00 sandpaper and remove all traces of dust using low-pressure compressed air.

### 8-25. INSPECTION.

a. Refer to table 1-1 and inspect parts for dimensional tolerances.

b. Inspect housings and commutator end head, pinion teeth and splines for scratches, burrs, nicks and cracks.

c. Inspect bushings for discoloration rough spots, score marks, scratches and nicks.

d. Inspect threaded parts for thread damage.

e. Inspect commutator on armature (46, figure 8-7) for rough spots, discoloration, pitting, scoring, and high-mica.

f. Inspect armature shaft (46) for pitting, scoring, or excessive wear. Inspect starter drive (79) for broken teeth on pinion. Check to see that starter drive (79) clutch assembly moves on armature shaft (46) to see if splines fit properly.

g. Inspect solenoid switch (21) parts. Check condition of moving core and sealing boot. Check connector (5 ) and terminal studs to see if they are burned, eroded, or pitted excessively.

h. Using a suitable spring scale, check brush springs (52 and 58 ) tension. Tension should be 2.25 to 2.50 ounces.

i. Inspect spring (16) for free length of 2.7920 inches. Compress spring to 1.56 inches. Load should be 13.5 to 14.5 pounds.

j. Refer to Appendix A for Electric Motor and Generator Repair Manual, and check armature and field coils for shorts, open circuits, and grounds. Check armature for shorts using a suitable growler.

## 8-26. REPAIR.

a. Refer to Appendix A for Electric Motor and Generator Repair Manual for general repair instructions.

b. Remove minor nicks and burrs from housings, commutator end head, pinion teeth and splines using a suitable hone.

c. Replace discolored, spotted or scored bushings. Remove minor nicks and scratches from bushings using crocus cloth dipped in an approved cleaning solvent.

d. Repair minor thread damage using a suitable thread chaser.

NOTE

Armature must be replaced if commutator diameter is not within limits specified in table 1-1 after repair.

e. Repair commutator on armature (46 figure 8-7) by turning it down using a suitable lathe. Take light cuts until all defects are removed. Remove all burrs by holding No. 00 sandpaper lightly against commutator. Undercut mica to a depth of 1/32 of an inch using a suitable mica undercutter.

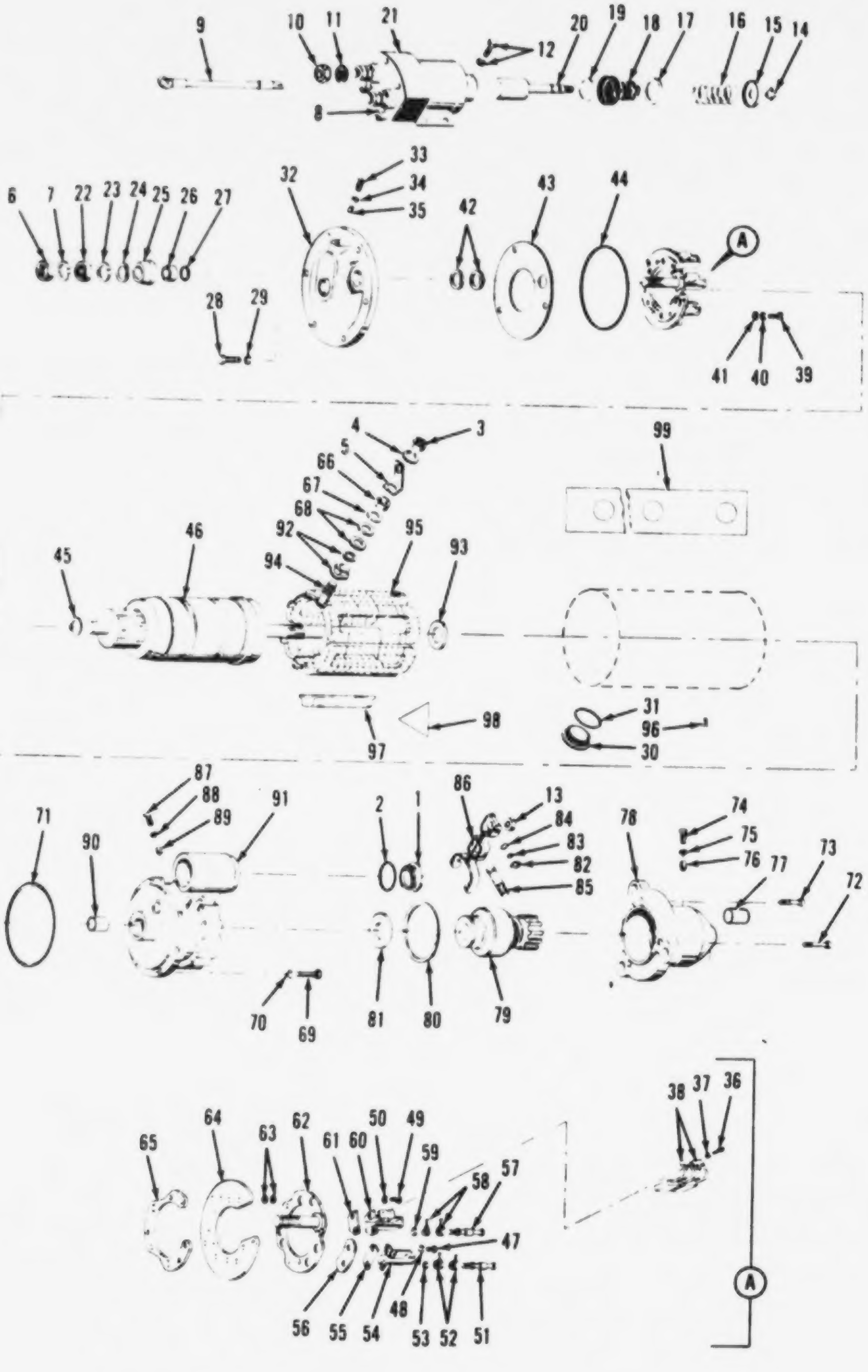
f. Replace parts that are not within dimensional tolerances specified in table 1-1.

## 8-27. REASSEMBLY.

Refer to figure 8-7 and reassemble starting motor in the reverse order of index numbers assigned. Pay particular attention to the following:

a. When installing new bushings (26, 77, and 90), always use proper bushing arbor to obtain a proper fit. Remove wicks ( 35, 76, and 89) from commutator end frame (32), drive housing (78), and lever housing (91). reservoirs before installing new bushings (26, 77, and 90). After new bushings installation, saturate felt wicks with SAE 10 oil, install wicks in reservoirs, and fill reservoirs with SAE oil.

b. Lubricate packings (44, 80 and 71) with a film of light grease MIL-G-23827 to prevent damage during reassembly.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52
51

Figure 8-7. Starter motor, exploded view

Legend to figure 8-7:

1. Plug
2. Gasket
3. Nut
4. Lock washer
5. Connector
6. Nut
7. Lock washer
8. Screw
9. Terminal and lead
10. Nut
11. Lock washer
12. Screw assembly (4)
13. Nut
14. Snap ring
15. Retainer
16. Spring
17. Retainer
18. Boot
19. Washer
20. Plunger assembly
21. Solenoid switch
22. Nut
23. Lock washer
24. Washer
25. Insulator
26. Bushing
27. Packing
28. Screw (6)
29. Lock washer (6)
30. Plug
31. Gasket
32. Commutator end frame
33. Plug
34. Bushing
35. Wick
36. Screw (12)
37. Lock washer (12)
38. Brush (12)
39. Screw (3)
40. Lock washer (3)
41. Washer (3)
42. Washer (2)
43. Insulator
44. Packing
45. Washer
46. Armature
47. Screw (3)
48. Lock washer (3)
49. Screw (3)
50. Lock washer (3)
51. Screw (3)
52. Spring
53. Lock washer (3)
54. Brush holder (3)
55. Plate (3)
56. Insulation (3)
57. Screw
58. Spring (6)
59. Lock washer (3)
60. Brush holder (3)
61. Plate (3)
62. Plate and stud
63. Bushing (6)
64. Plate
65. Plate
66. Nut
67. Washer
68. Washer (2)
69. Screw (7)
70. Lock washer (7)
71. Packing
72. Screw (5)
73. Screw
74. Plug
75. Bushing
76. Wick
77. Bushing
78. Drive housing
79. Motor drive
80. Gasket
81. Washer
82. Snap ring
83. Packing
84. Packing
85. Shaft
86. Lever
87. Plug
88. Bushing
89. Wick
90. Bushing
91. Lever housing
92. Insulator
93. Washer
94. Stud
95. Field coil assembly
96. Screw (12)
97. Pole shoe (4)
98. Insulation (3)
99. Insulator

**c. Lubricate armature (46) bushing surfaces on shaft with SAE 10 oil. Lubricate shaft and splines under starter drive (79) with grease that conforms to Military Specification MIL-G-23827.**

**d. Install armature (46) and seat brushes (38) as follows:**

**1. Install armature (46) in frame and field coil assembly (95) and lever housing (91).**

**2. Cut a strip of No. 00 sandpaper the width of the armature (46) commutator. Install sandpaper on armature (46) commutator with sand side out.**

3. Assemble brush rigging (view A) and install on commutator end frame (68).

4. Pull armature (46) out of field coil frame just far enough to permit brushes (38) to be placed on sandpaper. Brushes (38) must lie flat against sandpaper on armature (46) commutator to obtain desired brush seat contour. Install commutator end frame (68) and armature (46) back against the field coil frame (95).

5. Carefully rotate armature (46) in a counterclockwise direction three to five revolutions to properly seat brushes.

6. Remove commutator end frame (68) and lift brushes (38) and inspect seat contour to determine whether or not sanding operation is satisfactory. A satisfactorily seated brush (38) should show evidence of contact on at least 85 percent of its length and 100 percent of its thickness.

7. Lift brushes (38) and remove commutator end frame (68). Remove sandpaper from armature (46) commutator.

8. Remove armature (46) from frame and field coil assembly (95). Clean armature (46), brushes (38), and frame and field coil assembly (95). Blow out sanding dust using compressed air.

9. Coat shaft and splines on armature (46) with grease MIL-G-23827. Install armature (46) (steps 1. and 2. above).

e. When assembling lever, drive, and commutator end drive housing assemblies (91, 78, and 32), torque screws (69, 72, 73, and 28) to 13 to 17 foot pounds. Make sure locating marks are aligned.

f. After assembly, the insulation on both terminal studs on frame and field coil assembly (95) should be coated with glytal sealant. Keep sealant off of contact surfaces of terminal studs and nuts.

8-28. TESTING. (See figure 8-8.)

a. The following equipment will be required to perform the starter tests:

1. Two 12 volt batteries will be required.

2. D. C. voltmeter (0 to 50 volt scale).

3. D. C. ammeter (0 to 500 amp scale).

4. Carbon pile (0 to 600 amp capacity).

5. Hand held tachometer - 0-10,000 RPM.

NOTE

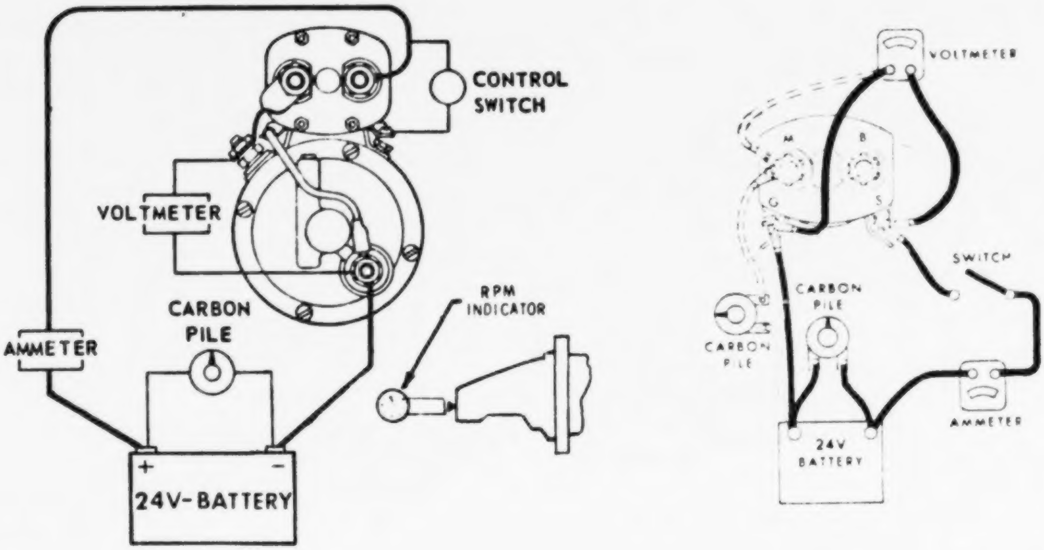
Never operate the starter motor more than 30 seconds at a time during test. Allow the motor to cool for at least 2 minutes between each crank cycle.

b. No load test.

1. Connect no load current test setup as shown in view A.

2. Adjust carbon pile to obtain a voltage of 20 volts. Current drain should be 95 amperes (minimum) to 120 amperes (maximum) at 5500 (minimum) to 7500 (maximum) RPM.

3. Apply rubber tip of hand held tachometer to end of shaft in drive housings to read RPM.


CONTROL SWITCH
VOLTMETER
CARBON PILE
AMMETER
RPM INDICATOR
+
-
24V-BATTERY
VOLTMETER
M
B
G
S
SWITCH
CARBON PILE
CARBON PILE
AMMETER
24V BATTERY

A NO LOAD TEST

B SOLENOID WINDING TEST

Figure 8-8. Starting motor, test setup

4. If current is too high, check bearing alignment end play. Two or three sharp raps with a rawhide hammer while motoring will often help align bearings and free armature.

c. Solenoid winding test.

CAUTION

To prevent overheating, do not leave pull-in winding energized more than 15 seconds.

1. Make solenoid winding test setup as shown in view B.

2. Test current draw and make ground and open test on windings. Hold-in winding (solid lines) values should be 6.8 amperes maximum at 20 volts. Pull-in winding values (dotted lines) should be 10 to 11.5 amperes at 5 volts. Adjust carbon pile to obtain proper test voltage.

d. Pinion clearance adjustment. (See figure 8-9.) This adjustment assures correct relation between solenoid and indexing drive assembly. If adjustment is not correct, damage may result to drive gear and/or flywheel ring gear.

1. Disconnect motor field coil connector (5, figure 8-7) from the solenoid motor terminal.

2. Connect a 24 volt battery as shown in view A, figure 8-9.

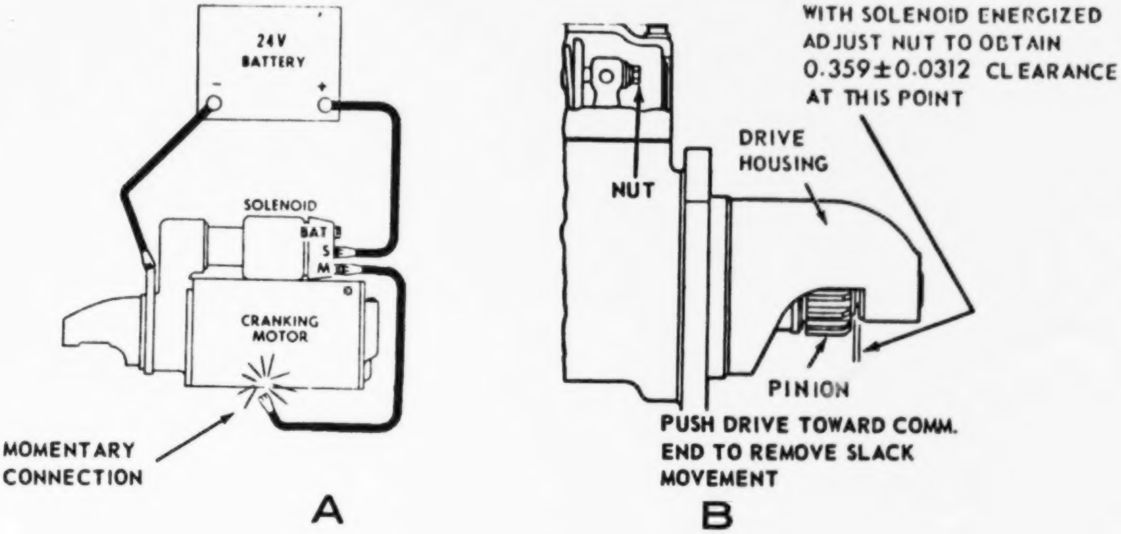

24V
BATTERY
-
+
SOLENOID
BAT
S
M
CRANKING
MOTOR
MOMENTARY
CONNECTION
A
WITH SOLENOID ENERGIZED
ADJUST NUT TO OBTAIN
0.359±0.0312 CLEARANCE
AT THIS POINT
DRIVE
HOUSING
NUT
PINION
PUSH DRIVE TOWARD COMM.
END TO REMOVE SLACK
MOVEMENT
B

Figure 8-9. Starting motor pinion clearance, test setup

3. Momentarily touch the jumper load from the solenoid motor to the motor frame. This will shift solenoid and drive assembly into cranking position until battery is disconnected.

4. Push drive assembly toward commutator end of motor to eliminate any slack movement in linkage.

5. Measure the distance between the pinion and drive housing as shown in view B. This distance should be 0.359 ± 0.0312 inches. If measurement is not correct, remove plug and washer from shift linkage cover and adjust nut as required to obtain proper measurement. Disconnect battery.

6. Reinstall plug and washer in shift linkage cover.

## 8-29. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install starting motor.

## Section V. FAN MOUNTING GROUP

### 8-30. GENERAL.

The fan mounting group is mounted at the front of the engine. It consists of a fan, drive pulley, brackets, and mounting hardware. The fan and pulley are driven by the crankshaft pulley via the fan drive belts. The fan forces cooling air through the radiator.

### 8-31. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual and remove alternator belts, fan drive belts, fan guard and orfice ring on radiator shroud, and hydraulic tank on precise sets.

CAUTION

Do not allow fan to hit radiator core after it is removed from fan hub.

b. Refer to figure 8-10 and remove fan and fan drive in the order of index numbers assigned.

### 8-32. DISASSEMBLY.

Refer to figure 8-11 and disassemble fan drive assembly in the order of index numbers assigned.

### 8-33. CLEANING.

CAUTION

Do not spin dry bearings.

a. Wash parts in an approved cleaning solvent and dry thoroughly. Bearings should be dried with compressed air.

b. Clean pulley cavity of old grease. Flush with cleaning solvent and air dry.

### 8-34. INSPECTION.

a. Inspect bearings for roughness of rotation. Replace bearing if its rotation is rough after lubrication.

b. Inspect bearings for scoring, pitting, scratches, cracks and discoloration. Replace defective bearing.

c. Inspect spindle and bracket assembly bearing surface for grooves, or galled conditions. Replace defective spindle and bracket assembly.

d. Inspect fan for distorted blades, worn pilot hole or elongated mounting holes. Replace defective fan.

e. Inspect pulley for worn grooves, nicks or cracks. Replace worn or cracked pulley.

f. Inspect threaded holes for thread damage.

g. Discard gasket and seal.

### 8-35. REPAIR.

a. Minor nicks and burrs on fan and pulley may be removed using a suitable stone.

b. Repair minor thread damage using a suitable thread chaser.

### 8-36. REASSEMBLY.

Refer to figure 8-11, and reassemble fan drive assembly in the reverse order of index numbers assigned. Pay particular attention to the following:

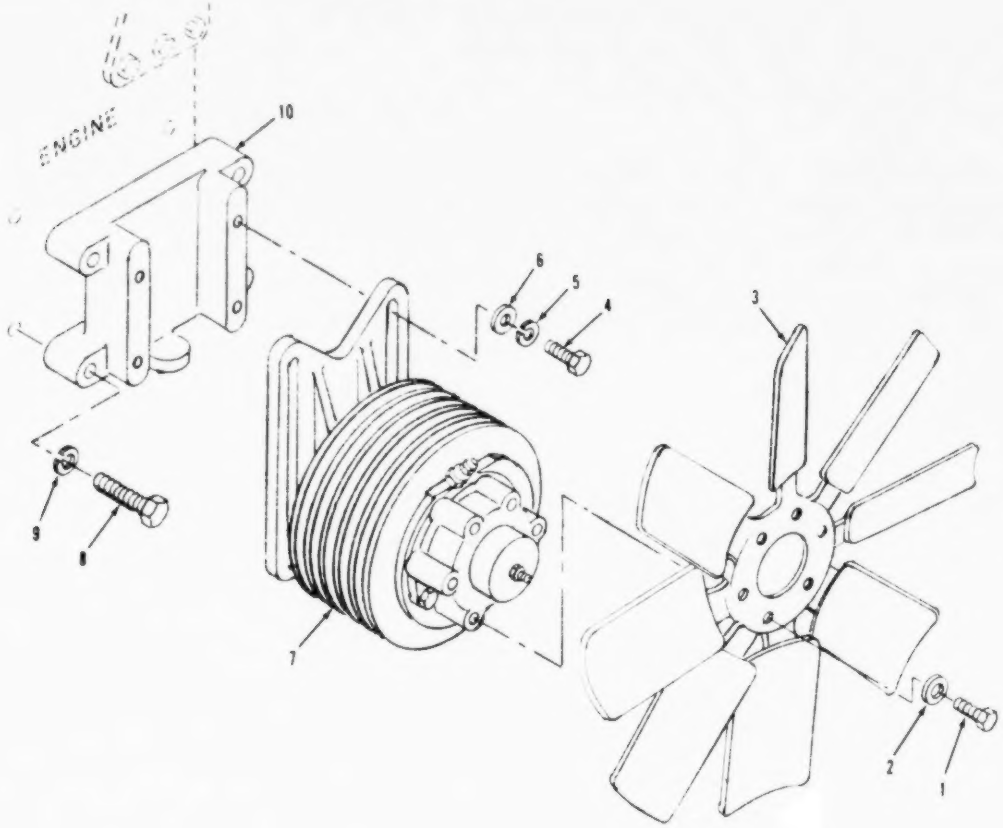


Figure 8-10. Fan and fan drive group, removal and installation

Legend to figure 8-10:

1. Bolt (6)
2. Lock washer (6)
3. Fan
4. Bolt (4)
5. Lock washer (4)
6. Washer (4)
7. Fan drive assembly
8. Bolt (4)
9. Lock washer (4)
10. Spacer

a. Install seal (12) with lip away from bearing (13). Lubricate sealing lip of seal (12) lightly with engine oil.

b. Hand pack bearings (13 and 10) with grease before reassembly.

c. Install bearing (10) with high edge on inner race toward spacer (11).

d. Completely fill cavity between bearings (13 and 10) with grease.

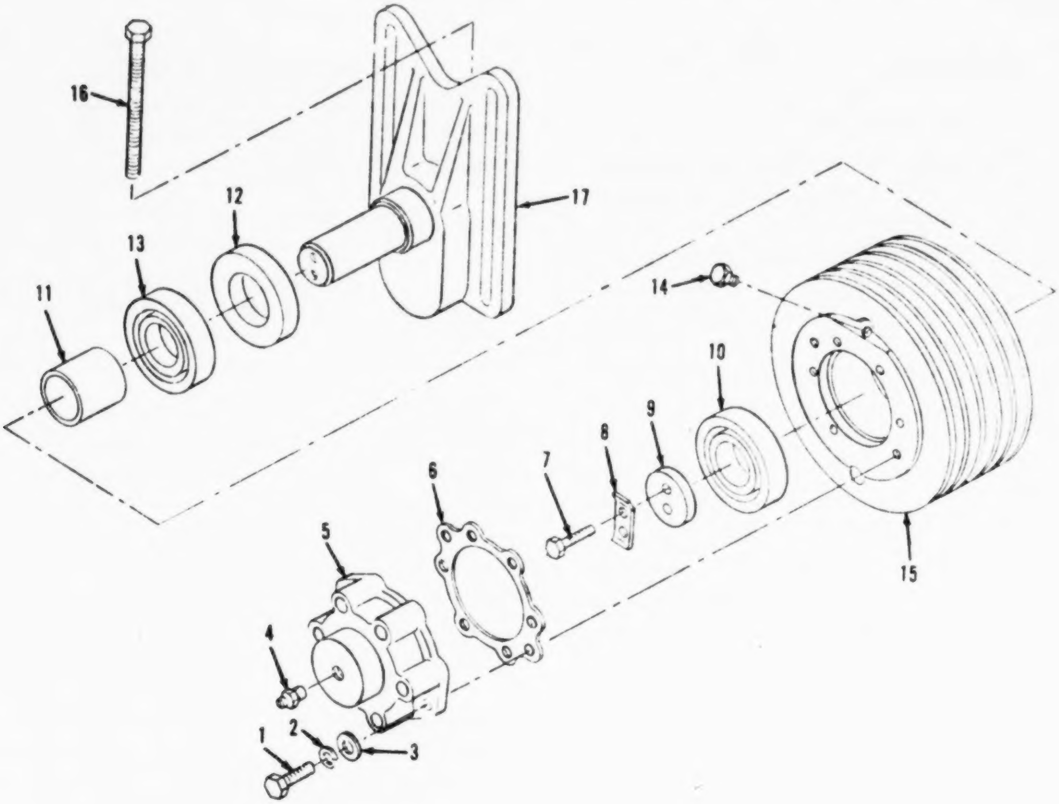


Figure 8-11. Fan drive assembly, exploded view

Legend to figure 8-11:

1. Bolt (2)
2. Lock washer (2)
3. Washer (2)
4. Fitting
5. Hub
6. Gasket
7. Bolt (2)
8. Lock
9. Washer
10. Bearing
11. Spacer
12. Seal
13. Bearing
14. Plug
15. Pulley
16. Bolt
17. Bracket assembly

## 8-37. INSTALLATION.

Refer to figure 8-10 and install fan drive group in reverse order of index numbers assigned. Pay particular attention to the following.

a. Before installing fan drive assembly (7, figure 8-10), place fan belts and alternator belt on crankshaft pulley and fan drive pulley.

b. Refer to Operator and Organizational Maintenance Manual and tighten fan and alternator drive belts. Install fan guard and orifice ring on radiator shroud.

## Section VI. DAY TANK ASSEMBLY

### 8-38. GENERAL.

The day tank is mounted on the unit lifting frame and is located on the left side of the engine. It provides a gravity head of fuel to the fuel injection pump. The day tank is non-pressurized and is equipped with a fuel level switch, a drain cock, a vent, a fuel inlet port, a fuel outlet port, and an excessive fuel return port. The fuel level switch is one of the dual float type: the upper float, senses fuel level and prevents the overflow of fuel in day tank: the lower float senses fuel level and stops the engine after the fuel supply to the day tank has been shut off for 4 minutes. The drain cock is provided to completely drain the day tank, and the vent prevents the system from becoming air bound. The day tank has a usable fuel capacity sufficient for a minimum of 5 minutes operation at rated load, after the fuel supply to the day tank has been shut off.

### 8-39. REMOVAL AND DISASSEMBLY.

Refer to Operator and Organizational Maintenance Manual. Remove and disassemble day tank assembly.

### 8-40. CLEANING.

#### WARNING

Trichlorethylene, Military Specification MIL-T-7003 is toxic and should be used only in a well ventilated area.

a. Clean fuel level switch with trichlorethylene, Military Specification MIL-T-7003.

b. Clean the day tank using clean fuel oil. Be sure that any sediment in the bottom of the tank is flushed out. After cleaning, dry tank thoroughly.

### 8-41. INSPECTION.

a. Refer to Operator and Organizational Maintenance Manual, and test fuel level switch.

b. Block openings in day tank and apply 1 psi of air pressure to tank. Submerge the tank in water, leaks will be indicative by air bubbles.

c. Inspect all threaded holes for damaged threads.

### 8-42. REPAIR.

a. Replace defective fuel level switch.

#### WARNING

Make sure inside of day tank is free of fuel fumes and all tank ports are open before welding.

b. Repair leaks in day tank by welding.

c. Recheck day tank for leaks after welding (para 8-41b.)

d. Repair minor thread damage, using a suitable chaser.

### 8-43. REASSEMBLY AND INSTALLATION.

Refer to Operator and Organizational Maintenance Manual. Reassemble and install day tank assembly.

## Section VII. OVERSPEED SWITCH

### 8-44. GENERAL.

The overspeed switch is mounted on the tachometer drive and operates at one half engine speed. It is a three element switch. Switch 1, disconnects starter and initiates field flashing of generator. Switch 2, permits 24 VDC to energize precise governor (precise sets only). Switch 3, initiates shutdown sequence of generator set in the event engine speed increases to 2200-2250 RPM. Switch 3 must be manually reset when tripped, by depressing the reset button.

### 8-45. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove overspeed switch.

### 8-46. DISASSEMBLY.

Refer to figure 8-12 and disassemble overspeed switch in the order of index numbers assigned. Pay particular attention to the following:

a. Remove lockwire (1) and remove three screws (2). Mark three hole center location on cap and cover assembly (6) with scribe marks.

b. Separate cap and cover assembly (6) from body assembly (11).

c. Remove cap and cover retaining screws (12) and lift cover from cover assembly (6).

d. Remove rotor assembly (9) by releasing retaining ring (8) which secures rotor assembly to body assembly (11). Retaining ring will come out with rotor assembly.

### 8-47. CLEANING.

#### CAUTION

Do not immerse overspeed switch in cleaning solvent.

a. Wipe outside of overspeed switch with a clean cloth moistened with an approved cleaning solvent and dry thoroughly.

b. Low pressure compressed air may be used to remove any dust or dirt deposits in switch assembly.

### 8-48. INSPECTION.

a. Inspect cap and cover assembly, and body assembly for cracks and loose hardware.

b. Inspect rotor assembly (9) bearing for freedom of rotation. Replace rotor assembly if bearing is frozen.

c. Inspect switch assembly inside of cap and cover assembly (6) for quality of solder connections on switch terminals. Check for corrosion on switch terminals.

d. Inspect for freedom of movement of switch contact actuator plate. Depress actuator plate with thumb on center of actuator plate. There should be a total of three separate clicks as each micro switch is actuated while the actuator plate is depressed to its lower limit. If third click is not indicated, reset manual reset button. Replace cover assembly (6) if switch/or switches are defective.

e. Inspect inside of body assembly for signs of moisture or corrosion.

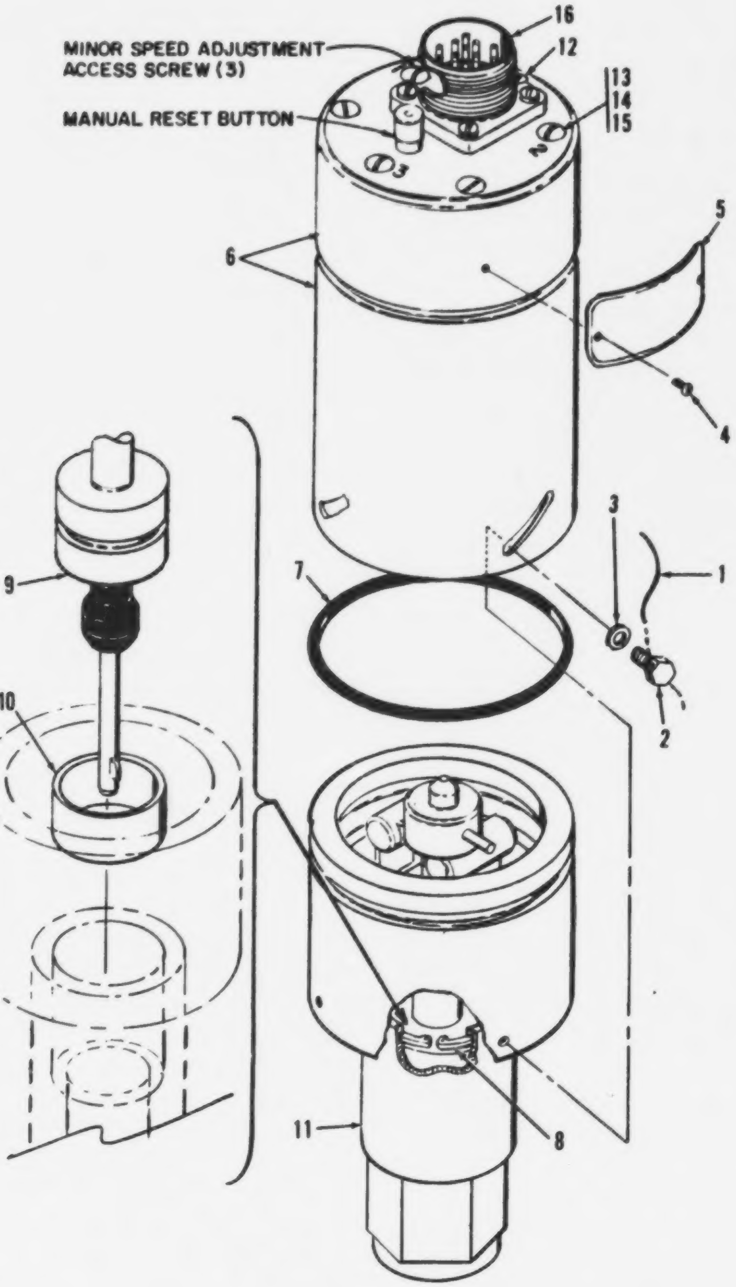

16
MINOR SPEED ADJUSTMENT ACCESS SCREW (3)
12
13
14
15
MANUAL RESET BUTTON
5
6
4
3
1
7
9
2
10
11
8

Figure 8-12. Overspeed switch, exploded view

Legend to figure 8-12:

1. Lockwire
2. Screw (3)
3. Washer (3)
4. Screw (2)
5. Nameplate
6. Cap and cover assembly
7. Packing
8. Retaining ring
9. Rotor assembly
10. Spacer
11. Body assembly
12. Cap and cover retaining screws (3)
13. Screw (4)
14. Nut (4)
15. Washer (4)
16. Connector

f. Inspect governor weights for freedom of movement.

g. Inspect electrical wires inside of cap and cover assembly (6) for insulation, continuity, and proper connection. Replace defective wires.

h. Inspect electrical connector for damaged threads, bent, loose, or missing pins; and for shorts. Replace defective connector.

i. Discard packing.

## 8-49. REPAIR.

a. If electrical connector (16) is defective, remove connector from cover by removing screws (13), nuts (14), and washers (15). Tag electrical leads and unsolder wires from connector.

b. Install new electrical connector (16) to cover and secure with screws (13), nuts (14), and washers (15). Solder wires to connector.

## 8-50. REASSEMBLY.

Refer to figure 8-12 and reassemble overspeed switch in the reverse order of index numbers assigned. Pay particular attention to the following.

a. Position rotor assembly (9) into body assembly (11) and secure with retaining ring (8).

b. Position cap onto cover assembly (6) and secure with screws (12).

c. Align cap and cover assembly (6) to body assembly so the three slots match up with screw holes in body assembly (11). Install screws (2) and washers (3), and align assemblies with hole center location scribe marks. Do not lockwire screws (2) at this time.

## 8-51. ADJUSTMENT.

### a. MAJOR SPEED ADJUSTMENT.

NOTE

If speed switch has been disassembled, steps a. and b. both must be performed. If switch has not been disassembled and only a minor adjustment is required, perform step b. only.

1. Remove minor speed adjustment access screws on top of cap which provide access to adjusting screws. Insert a 1/16 inch (1.588 mm) hex Allen wrench into adjusting screws.

NOTE

Do not allow screw to be disengaged from lock nut assembly.

2. Turn switch 1 adjusting screw all the way counterclockwise.

3. Turn switch 2 adjusting screw approximately halfway between its minimum and maximum adjustment range.

4. Turn switch 3 adjusting screw in a clockwise direction until adjustment screw is flush with top of lock nut.

5. Rotate cap and cover assembly (6) counterclockwise to maximum extended position.

6. Connect overspeed switch to test setup as shown in figure 8-13.

7. Set variable speed drive at approximately 200 RPM above actuation point of switch 1. Speed of variable drive must be measured with a tachometer of ±1 percent accuracy.

8. Rotate cap and cover assembly (6, figure 8-12) clockwise until switch 1 actuates. Scribe this position on body assembly (11) and cap and cover assembly (6).

9. Rotate cap and cover assembly (6) clockwise an additional 1/16 of an inch (1.587 mm) and lock the three screws.

10. Proceed to set trip points of two remaining switches, step b.

b. MINOR SPEED ADJUSTMENT.

CAUTION

Too many counterclockwise turns will remove setscrew from lock nut assembly.

NOTE

All three switches may be individually adjusted. Under certain conditions the adjustment of one switch may slightly effect the speed setting of the other two. Compensating adjustments may be required. Switch 1 setscrew will be turned clockwise to increase speed to proper trip while switch 3 setscrew will be turned counterclockwise to decrease trip points. Switch 3 setscrew should require adjustment either clockwise or counterclockwise (increase or decrease) depending upon where it actuates.

1. Perform step a., 1. above.

2. Turn adjusting screw clockwise to increase trip point and counterclockwise to decrease trip point. Set switches to speeds indicated below by changing speed setting of the test stand motor to a point midway in the speed band range.

Switch 1 - set at 290 to 310 RPM
(30.363 to 32.457 r/sec.)
Switch 2 - set at 590 to 610 RPM
(61.773 to 63.867 r/sec.)
Switch 3 - set at 1200 to 1225 RPM
(125.64 to 128.257 r/sec.)

3. Recheck all trip point settings.

4. After all bench adjustments have been made, tighten cover hardware (2 and 3) and install lockwire (1).

## 8-52. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install overspeed switch. Check to be sure reset button has not tripped during installation.

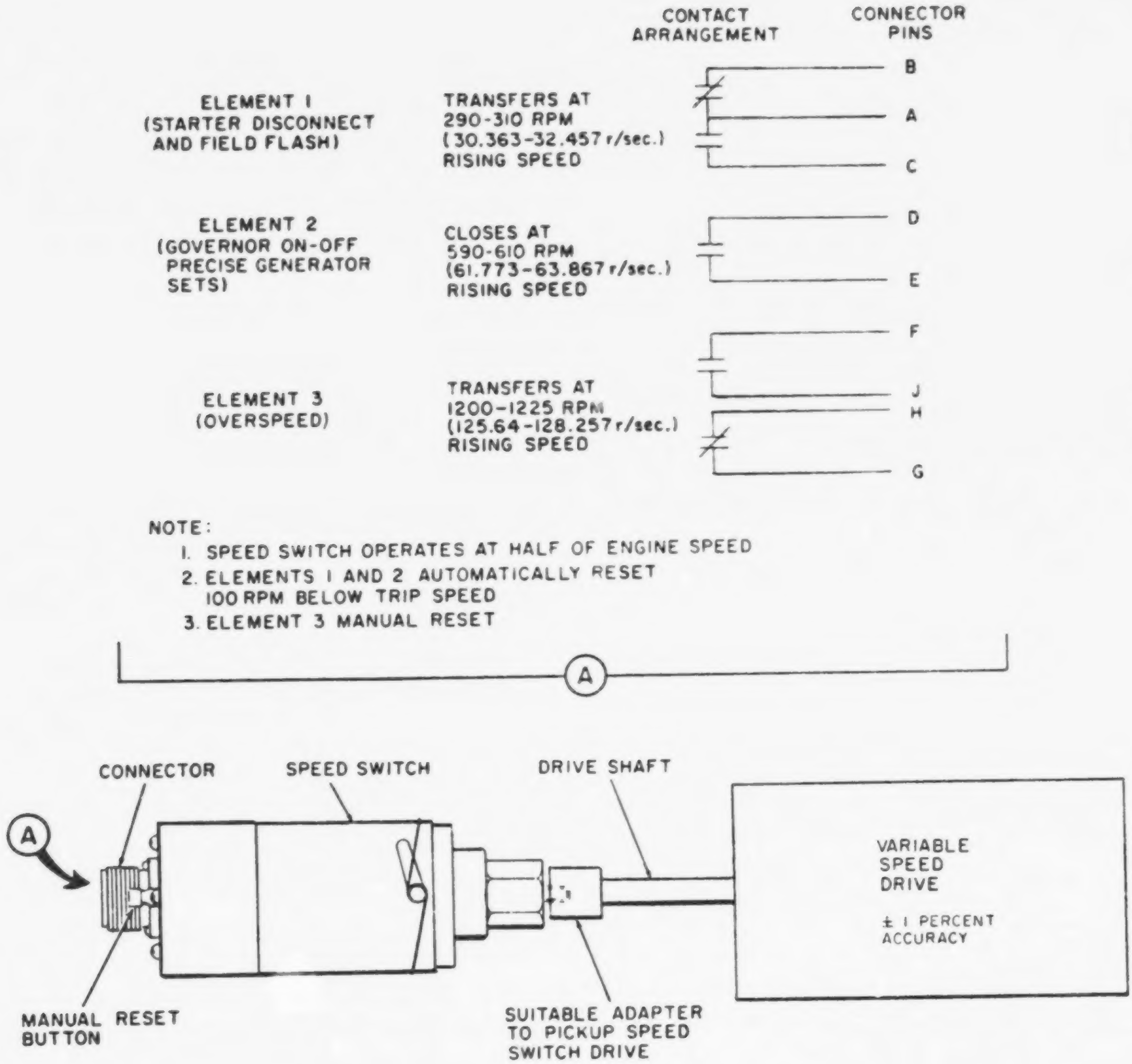

CONTACT ARRANGEMENT
CONNECTOR PINS
ELEMENT 1 (STARTER DISCONNECT AND FIELD FLASH)
TRANSFERS AT 290-310 RPM (30.363-32.457 r/sec.) RISING SPEED
B
A
C
ELEMENT 2 (GOVERNOR ON-OFF PRECISE GENERATOR SETS)
CLOSES AT 590-610 RPM (61.773-63.867 r/sec.) RISING SPEED
D
E
ELEMENT 3 (OVERSPEED)
TRANSFERS AT 1200-1225 RPM (125.64-128.257 r/sec.) RISING SPEED
F
J
H
G
NOTE:
1. SPEED SWITCH OPERATES AT HALF OF ENGINE SPEED
2. ELEMENTS 1 AND 2 AUTOMATICALLY RESET 100 RPM BELOW TRIP SPEED
3. ELEMENT 3 MANUAL RESET
A
CONNECTOR
SPEED SWITCH
DRIVE SHAFT
A
VARIABLE SPEED DRIVE
± 1 PERCENT ACCURACY
MANUAL RESET BUTTON
SUITABLE ADAPTER TO PICKUP SPEED SWITCH DRIVE

Figure 8-13. Overspeed switch, test setup

## Section VIII. OVERSPEED GOVERNOR DRIVE GROUP

### 8-53. GENERAL.

The overspeed governor drive group is mounted and driven off the fuel pump. The tachometer drive drives the overspeed switch at 1/2 engine speed.

### 8-54. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual and remove overspeed switch.

b. Refer to figure 8-14 and remove tachometer drive group by removing bolts (1), lock washers (2) and clamps (3 and 4).

### 8-55. DISASSEMBLY.

Refer to figure 8-14 and disassemble overspeed governor drive group in the order of index numbers assigned. Pay particular attention to the following.

a. Bearings (8, 15, and 21) are press fitted. If necessary, remove bearings using suitable removal tools.

### 8-56. CLEANING.

a. Clean parts with an approved cleaning solvent. Scrub parts thoroughly using a stiff bristle brush.

b. Dry parts with filtered low pressure compressed air or a clean lint-free cloth.

### 8-57. INSPECTION.

a. Inspect bearings (8, 15, and 21) for scoring, pitting, scratches, and cracks. Replace defective bearings.

b. Inspect housing for cracks. Replace cracked housing.

c. Inspect gear teeth for nicks, burrs, cracks, and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of the gear.

d. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

e. Inspect gear shafts, for nicks, burrs, and scratches.

f. Discard seal.

### 8-58. REPAIR.

a. Remove minor nicks and burrs from gear teeth and gear shafts using a smooth file or hone.

b. If gears must be replaced, press gears from shaft using a suitable arbor press. Apply an approved adhesive to gear diameter of shaft and press gear onto shaft. Press fit must withstand 10 ft-lbs (1.383 kg-meters) torque.

### 8-59. REASSEMBLY.

Refer to figure 8-14, and reassemble overspeed governor drive group in the reverse

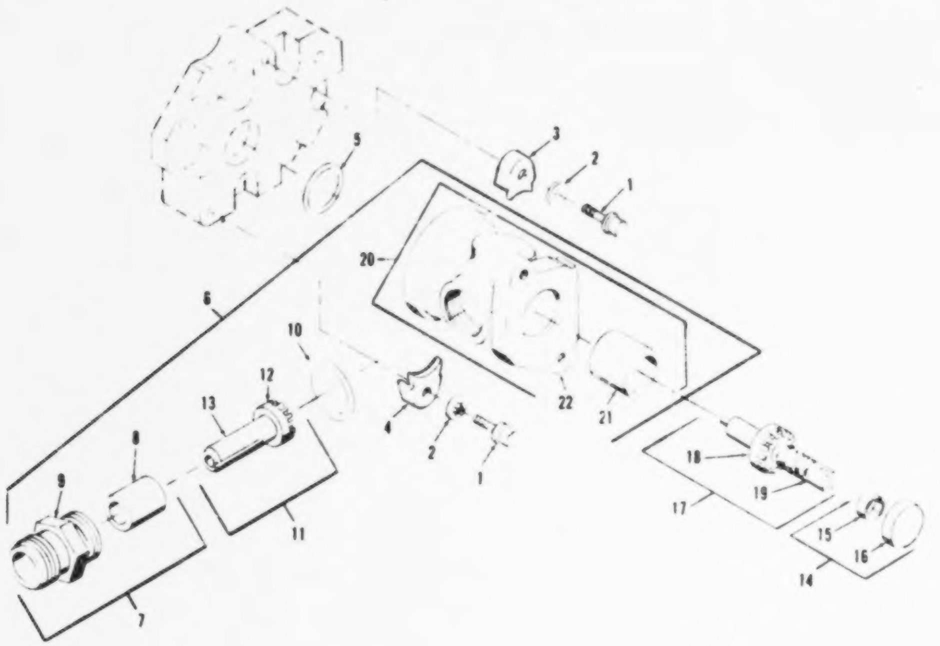


Figure 8-14. Overspeed governor drive group, exploded view

Legend to figure 8-14:

1. Bolt (2)
2. Lock washer (2)
3. Clamp
4. Clamp
5. Seal
6. Overspeed governor drive
7. Housing assembly
8. Bearing
9. Housing
10. Shim (14)
11. Shaft assembly
12. Gear
13. Shaft
14. Plug assembly
15. Bearing
16. Plug
17. Shaft assembly
18. Gear
19. Shaft
20. Housing assembly
21. Bearing
22. Housing

order of index numbers assigned. Pay particular attention to the following:

a. If bearings (8, 15, and 21) were removed, install new bearings. Bearings are press fitted.

b. Pack housing assembly (22) cavity with 7 cc's of approved lubricant.

c. Use required number of shims to produce 0.001 to 0.005 inch end play on shaft (11).

## 8-60. INSTALLATION.

a. Refer to figure 8-14 and install overspeed governor drive group, secure with bolts (1), lock washers (2), and clamps (3 and 4). Torque bolts (1) from 6 to 10 foot pounds.

b. Refer to Operator and Organizational Maintenance Manual and install overspeed switch.

## Section IX. FUEL PUMP GROUP

### 8-61. GENERAL.

The fuel pump is mounted to the accessory drive group, the pump is driven by a gear on the accessory drive shaft. The fuel pump consists of a gear driven shaft, slave bearings, fuel propelling gears, and seals. The pump causes fuel to flow from the day tank through secondary filter into fuel injection pump.

### 8-62. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual and remove overspeed switch.

b. Refer to Operator and Organizational Maintenance Manual and remove fuel hose from fuel pump.

c. Remove tachometer drive group (paragraph 8-54).

d. Refer to figure 8-15 and remove fuel pump by removing bolts (1), lock washers (2), and gasket (4).

### 8-63. DISASSEMBLY.

Refer to figure 8-15 and disassemble fuel pump group in the order of index numbers assigned. Pay particular attention to the following:

NOTE

Pump body (26) and cover (18) should be carefully separated due to the sealant that was used during assembly.

If necessary, remove gear (20) from shaft (21), using a suitable puller and step plate.

### 8-64. CLEANING.

Clean parts with an approved cleaning solvent and dry parts with low pressure compressed air.

### 8-65. INSPECTION.

a. Refer to table 1-1 and inspect fuel pump group for dimensional tolerances. Replace all parts that exceed maximum allowable wear and clearance.

Legend to figure 8-15:

1. Bolt (2)
2. Lock washer (2)
3. Fuel pump
4. Gasket
5. Nut
6. Gear
7. Key
8. Seal (2)
9. Ring
10. Gauge assembly
11. Seal (2)
12. Bearing
13. Gauge
14. Screw (6)
15. Cover assembly
16. Seal
17. Ferrule
18. Cover
19. Shaft assembly
20. Gear
21. Shaft
22. Gear
23. Body assembly
24. Shaft
25. Bearing
26. Body assembly

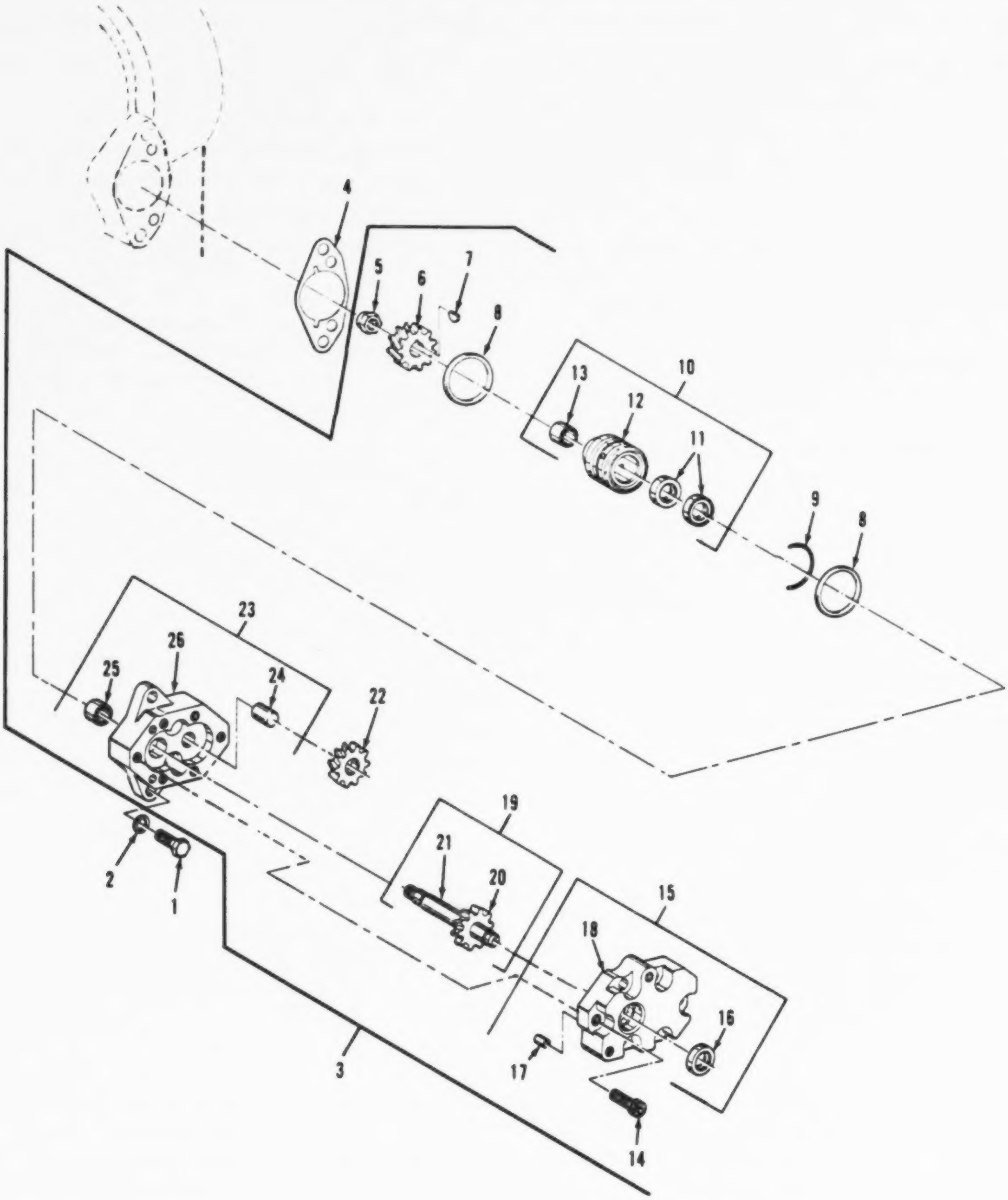

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Figure 8-15. Fuel pump group, exploded view

b. Inspect pump cover for nicks, scoring, and cracks. Replace defective cover.

c. Inspect gear teeth for nicks, burrs, cracks, and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of the gear.

d. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

e. Inspect gear shafts for nicks, burrs, and scratches.

f. Inspect bearings for scoring, pitting, scratches, and cracks.

g. Inspect a defective bearing's housing for grooved, burred, or galled conditions that would indicate that the bearing has been turning in its housing.

## 8-66. REPAIR.

Remove minor nicks and burrs from gear teeth and gear shafts using a smooth file or hone.

## 8-67. REASSEMBLY.

Refer to figure 8-15 and reassemble fuel pump group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Before installation, lightly lubricate seals (8, 11, and 16) with clean engine oil.

### CAUTION

Do not allow gasket paste to enter pump assembly.

b. Apply a thin coat of suitable gasket paste between body assembly (26) and cover (18).

c. Rotate pump shaft by hand to insure that pump parts rotate freely. If binding exists, tap corner of pump cover with a hammer to relieve binding.

d. Torque nut (5) from 17 to 27 foot pounds.

## 8-68. INSTALLATION.

a. Refer to figure 8-15 and install fuel pump, secure with bolts (1), lock washers (2), and gasket (4).

b. Install tachometer drive group (paragraph 8-60).

c. Refer to Operator and Organizational Maintenance Manual and install overspeed switch.

d. Refer to Operator and Organizational Maintenance Manual and connect fuel hose to fuel pump.

## Section X. TURBOCHARGER GROUP

### 8-69. GENERAL.

The turbocharger is mounted on the exhaust manifold. The turbocharger consists of a turbine wheel and a compressor impeller mounted on a common rotating shaft, a bearing housing, compressor cover, and compressor back plate. The turbocharger, which is driven by the engine exhaust gases, draws in ambient air, compresses the air, and directs it into the engine intake manifold. This process supercharges the engine which results in a greater power output.

### 8-70. REMOVAL.

Refer to Operator and Organizational Maintenance Manual, and remove the turbocharger group.

### 8-71. DISASSEMBLY.

Refer to figure 8-16 and disassemble turbocharger in the order of index numbers assigned. Pay particular attention to the following:

a. Cover all turbocharger openings and clean all exterior surfaces using a cleaning solvent that is in accordance with Federal Specification P-D-680. Dry unit thoroughly and remove opening coverings.

NOTE

Before removing wheel (48), mark shaft and wheel assembly (60). Rotating parts should be aligned during reassembly.

b. Before disassembly of parts, measure wheel (48) end clearance. End clearance should be 0.006 to 0.011 inch (.1524 to .2794 mm). If clearance is excessive, or if either the shaft and wheel assembly (60) or wheel (48) has rubbed against housing assembly (64) or shroud (61), the bearings (58) and/or thrust bearing (56) and collar (55) must be replaced.

c. Punch mark housing assembly (64), cover (66) and housing (68) to ensure correct positioning upon reassembly.

d. When removing wheel (48), remove nut (47) and then position compressor end of housing in a hot oil bath so only wheel is immersed. Heat wheel to 350°F(177°C) for not longer than 10 minutes. Remove unit from oil bath and press shaft and turbine wheel (60) as a unit from wheel(48).

### 8-72. CLEANING.

CAUTION

Rotating components must be thoroughly cleaned in order to maintain critical balance of turbocharger. Do not use a wire brush or wheel on any parts.

a. Clean all metal parts using an approved cleaning solvent. Dry parts thoroughly. Use a piece of wood to clean carbon and deposits from turbine housing (64, figure 8-16). Discard all seals and packings.

b. The turbine wheel must be cleaned thoroughly to remove all carbon deposits. It may be necessary to soak wheel in solvent for at least one hour to remove hardened carbon deposits. Scrape off loosened particles with a stiff brush or a specially shaped piece of wood. If turbine wheel is covered with soot only, use cleaning

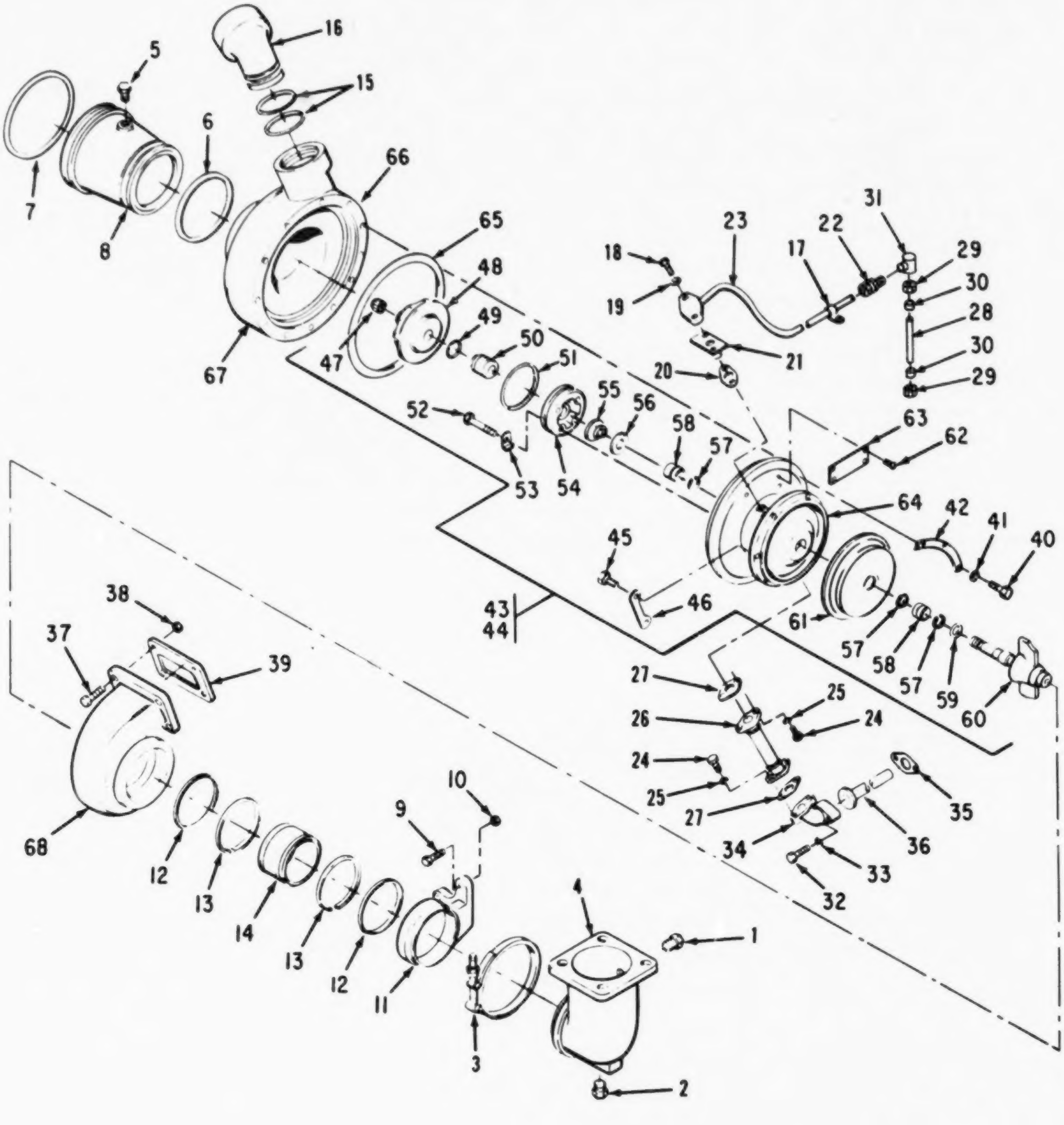
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Figure 8-16. Turbocharger Group

Legend to figure 8-16:

1. Plug
2. Plug
3. Clamp
4. Elbow
5. Plug
6. Seal
7. Seal
8. Adapter
9. Bolt (2)
10. Nut (2)
11. Support
12. Ring (2)
13. Expander (2)
14. Coupling
15. Seal (2)
16. Elbow
17. Clip
18. Bolt (2)
19. Lock washer (2)
20. Gasket (2)
21. Strainer
22. Fitting
23. Tube assembly
24. Bolt (4)
25. Lock washer (4)
26. Tube assembly
27. Gasket (2)
28. Tubing
29. Nut (2)
30. Sleeve (2)
31. Connector
32. Bolt (2)
33. Lock washer (2)
34. Elbow
35. Gasket (2)
36. Tube
37. Bolt (4)
38. Nut (4)
39. Gasket
40. Bolt (12)
41. Lock washer (12)
42. Clamp (6)
43. Cartridge assembly
44. Cartridge assembly
45. Screw (6)
46. Retainer (3)
47. Nut
48. Wheel
49. Ring
50. Spacer
51. Seal
52. Screw (4)
53. Plate (4)
54. Plate assembly
55. Collar
56. Bearing
57. Ring (3)
58. Bearing (2)
59. Ring
60. Wheel and shaft
61. Shroud
62. Screw (4)
63. Nameplate
64. Housing
65. Seal
66. Cover
67. Nameplate
68. Housing

solvent and a stiff brush, rinse with clean water, and dry thoroughly.

c. Clean oil passages in housing assembly using a pipe cleaner. This cleaning should be done only when the housing assembly has been completely disassembled.

## 8-73. INSPECTION.

Refer to table 1-1, and using a suitable micrometer and feeler gauge, inspect parts for dimensional tolerances. Replace parts that do not meet dimensional tolerances.

### CAUTION

The following step is a critical area of inspection. Any deformation or damage to wheels will cause a serious out-of-balance condition which will damage turbocharger.

b. Inspect compressor and turbine wheels (48 and 60, figure 8-16) for cracks, wear, chips, or any other defect. Check carefully for any blade distortion. If defective, replace wheel. Do not attempt to straighten blades.

c. Inspect bearings for cracks, distortion, or any other defect.

d. Check runout of shaft. This can be done by one of two methods. Use standard bearings and place shaft in vee blocks or use a partially open vise.

e. Inspect shaft for cracks, roughness, distortion, or any other defect. Check ring grooves for wear. Replace defective shaft.

f. Inspect housing for cracks, breaks, or any other defect. Replace defective housing.

g. Inspect all other parts for cracks, distortion, breaks, excessive wear, or any other defect.

h. Inspect all attaching hardware for damaged threads, distortion, cracks, or any other defect.

## 8-74. REPAIR.

Repair damaged threaded holes for the oil pressure line flange bolts and for the drain line flange bolts in the housing assembly by retapping holes to clean out burrs and other obstructions.

## 8-75. REASSEMBLY.

Refer to figure 8-16, and reassemble turbocharger group in the reverse order of index numbers assigned. Pay particular attention to the following.

a. Torque bolt (52) from 36 to 44 inch pounds (4.07 to 4.97 newton/meters.

b. Install collar (55) so oil hole aligns with oil hole in housing (64).

c. Install wheel (48) on shaft and wheel assembly (60) as follows:

1. Place wheel (48) in an oil bath, heat wheel to a maximum of 350°F (177°C) for no longer than 10 minutes.

2. Remove wheel (48) from oil bath, and immediately install wheel on shaft, install old nut (47) and tighten to 150 inch pounds torque (16.95 newton/meters).

3. Allow wheel to cool to less than 150°F (65.6°C) and remove nut (47).

4. Using lubricating oil lightly lubricate the threads of turbine shaft and a new nut (47).

5. Install new nut (47) and tighten to 30 inch pounds (3.39 newton/meters) torque, then tighten an additional 90 degrees (1.571 radians).

6. Coat threads of bolts (45) (2 places) and bolts (40) with an approved anti-seize compound. Install both and tighten from 160 to 190 inch pounds (18.08 to 21.47 newton/meters) torque.

## 8-76. INSTALLATION.

Refer to Operator and Organizational Maintenance manual, and install the turbocharger group.

## Section XI. OIL COOLER GROUP

### 8-77. GENERAL.

The oil cooler group is mounted to the engine block. It consists of the oil cooler assembly, a water bonnet, and associated tubing and connections. The oil cooler assembly contains a tube bundle, and a housing. On cold engine starts, the cool viscous oil does not flow immediately through the oil cooler and oil filter. The cool oil forces bypass valves, located on the oil filter to open and the oil flows unrestricted through the engine and to the turbocharger. As the temperature of the oil increases, the viscosity and pressure of the oil decreases and the oil filter bypass valves close. Now, only filtered oil is delivered to all of the engine parts. As oil temperature continues to increase, the oil filter bypass valves close, allowing the oil to flow through the oil cooler prior to entering the oil filters. If an oil filter becomes clogged, that oil filter bypass valve opens and allows the oil to flow directly from the oil cooler into the engine. Water from the engine cooling system flows through the tube bundle section of the oil cooler to reduce the heat of the engine lubricating oil.

### 8-78. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual and disconnect water line from bottom of oil cooler.

b. Refer to figure 8-17, and remove oil cooler group in the order of index numbers assigned. Precise sets require removal of governor control prior to removal of oil cooler.

### 8-79. DISASSEMBLY.

Refer to figure 8-17 and disassemble oil cooler group in the order of index numbers assigned.

### 8-80. CLEANING.

a. If tube bundle is corroded, scale deposits can be removed by either of the following methods:

CAUTION

Care must be taken to avoid damaging sides of tubes.

1. Clean tubes with a suitable 5/32 inch (3.968 mm) diameter rod long enough to penetrate length of tubes.

WARNING

Wear protective clothing and use extreme caution when mixing acid solution, and when cleaning oil cooler. Always add acid to water when mixing; never add water to acid. Avoid any contact of solution with skin. Keep away from eyes.

2. Clean tubes with a solution of 15 percent hydrochloric acid and 85 percent water. The oil cooler should be immersed in or flushed with the solution until the scale is softened. Wash cooler thoroughly with water to remove scale and solution. Repeat procedure as necessary to achieve proper cleaning.

b. Clean metal components with an approved cleaning solvent, and dry thoroughly.

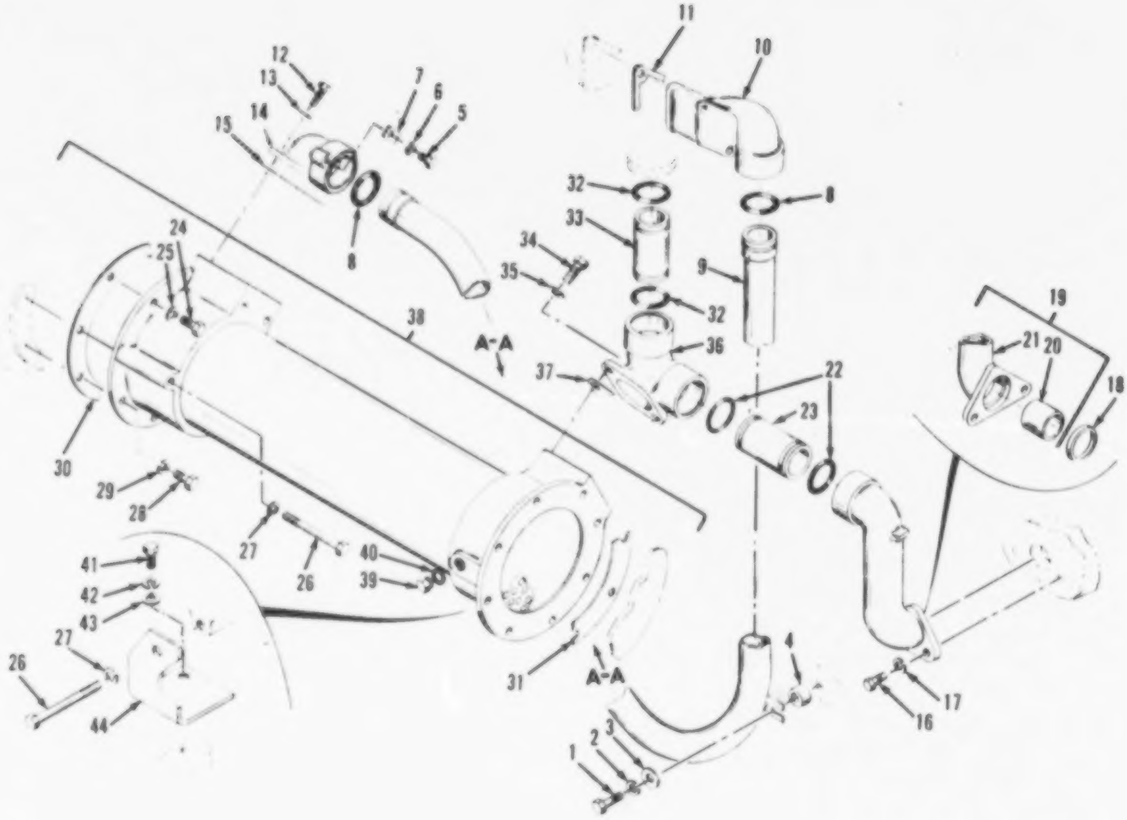
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Figure 8-17. Oil cooler group, removal and installation

## 8-81. INSPECTION.

a. Inspect tube bundle and end bonnets for cracks, breaks, corrosion that cannot be removed, and any other defects. Replace defective components.

b. Inspect components for dents, cracks, distortion, and damaged threads.

c. Discard gaskets and seals.

## 8-82. REPAIR.

a. Repair dents and distortion using proper tools.

b. Repair minor thread damage using a suitable thread chaser.

## 8-83. REASSEMBLY.

Refer to figure 8-17 and reassemble oil cooler group in the reverse order of index numbers assigned.

Legend to figure 8-17:

1. Bolt
2. Lock washer
3. Washer
4. Spacer
5. Bolt
6. Lock washer
7. Lug
8. Seal (2)
9. Tube assembly
10. Elbow
11. Gasket
12. Bolt (2)
13. Lock washer (2)
14. Elbow
15. Gasket
16. Bolt (2)
17. Lock washer (2)
18. Seal
19. Elbow assembly
20. Ferrule
21. Elbow
22. Seal (2)
23. Pipe
24. Bolt (4)
25. Lock washer (4)
26. Bolt (3)
27. Lock washer (3)
28. Bolt
29. Lock washer
30. Gasket
31. Gasket
32. Seal (2)
33. Pipe
34. Bolt (2)
35. Lock washer (2)
36. Elbow
37. Gasket
38. Core assembly
39. Plug (2)
40. Washer (2)
41. Bolt
42. Lock washer
43. Washer
44. Bracket

## 8-84. INSTALLATION.

a. Refer to figure 8-17, and install oil cooler group in the reverse order of index numbers assigned.

b. Install gasket and oil filler tube to cylinder block and secure with three washers, lock washers, and bolts.

c. Refer to Operator and Organizational Maintenance Manual and install oil filter group.

## Section XII. HYDRAULIC TANK (PRECISE SETS ONLY)

### 8-85. GENERAL.

The hydraulic tank is located on the right side at the front of the engine. It is mounted to the fan pulley support. The hydraulic tank is utilized on precise generator sets only. The function of the hydraulic tank is to provide a positive head of hydraulic fluid for the hydraulic pump. The tank contains a liquid level gauge at the top of the tank. A return line inlet is located below the lowest level of liquid allowed by the liquid level gauge. An outlet connection is located near the bottom of the tank. This location prevents sediment from following into the hydraulic system. A plugged outlet is located at the bottom of the tank for draining sediment. A drain plug at this outlet is of the magnetic type.

### 8-86. REMOVAL.

Refer to figure 8-18 and remove hydraulic tank in the order of index numbers assigned. Pay particular attention to the following:

a. Remove magnetic plug, and drain hydraulic fluid from tank. If hydraulic fluid is to be reused, drain fluid into a clean metal container. Loosen or remove liquid level gauge on top of tank in order to speed draining.

b. Disconnect hose assemblies (1 and 2) and drain fluid into the metal container. Cover container.

c. Install liquid level gauge, if removed.

d. Install magnetic plug.

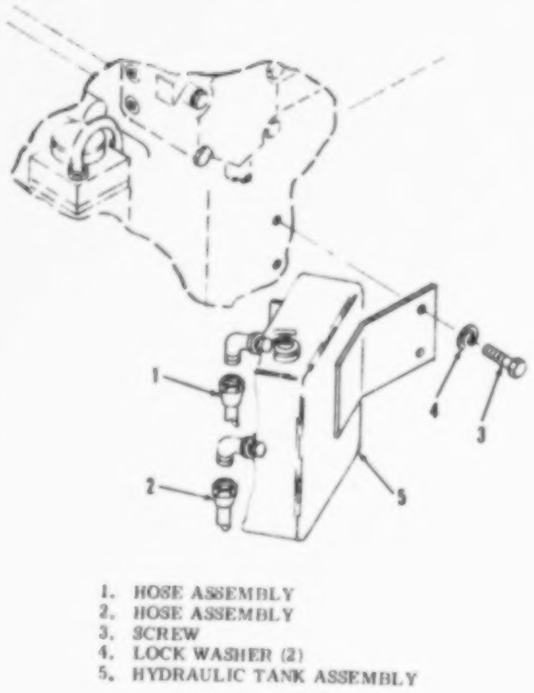

Figure 8-18. Hydraulic tank, removal and installation

Legend to figure 8-18:

1. Hose assembly
2. Hose assembly
3. Screw (2)
4. Lock washer (2)
5. Hydraulic tank assembly

## 8-87. DISASSEMBLY.

Refer to figure 8-19 and disassemble hydraulic tank in the order of index numbers assigned.

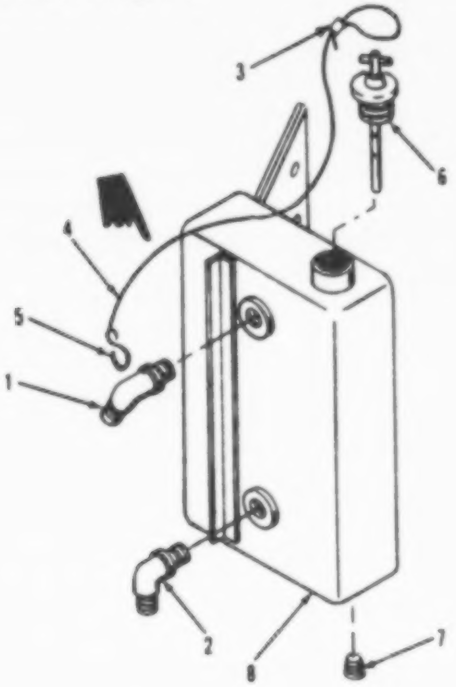

Figure 8-19. Hydraulic tank, exploded view

Legend to figure 8-19:

1. Elbow
2. Elbow
3. Sleeve
4. Rope assembly
5. Rope hook
6. Liquid level gauge
7. Magnetic plug
8. Hydraulic tank

## 8-88. CLEANING.

Clean components with an approved cleaning solvent, and dry thoroughly. Ensure that all particles trapped on head of magnetic plug are removed.

## 8-89. INSPECTION.

a. Inspect tank for leakage by air testing as follows:

1. Connect a suitable air supply to tank, and plug all openings.

2. Submerge tank in water, and apply air pressure of 1.5 PSI (.1054 kg/sq cm). Check for air bubbles.

b. Inspect liquid level gauge by holding gauge in hand and twisting handle in a clockwise direction. The rubber seal ring should swell slightly as handle is twisted. If rubber seal ring does not swell, replace liquid level gauge.

c. Inspect magnetic plug for its capability to pick up metal particles. If it has lost its magnetic capability, replace magnetic plug.

d. Inspect threaded holes in tank for damaged threads.

## 8-90. REPAIR.

a. Repair leakage or holes in tank as follows:

1. Steam clean tank.

2. Fill tank with water.

3. Repair tank by welding.

4. Repair tank with large holes by welding metal patches to tank.

5. After welding, drain water from tank.

6. Pressure test tanks for leakage in accordance with paragraph 8-89, step a.

b. Repair damaged threaded holes by retapping holes.

## 8-91. REASSEMBLY.

Refer to figure 8-19 and reassemble hydraulic tank in the reverse order of index numbers assigned.

## 8-92. INSTALLATION.

a. Refer to figure 8-18 and install hydraulic tank in the reverse order of index numbers assigned.

b. Refer to Operator and Organizational Maintenance Manual, and service hydraulic tank.

## Section XIII. HYDRAULIC PUMP (PRECISE SETS ONLY)

### 8-93. GENERAL.

The hydraulic pump is mounted to the hydraulic pump drive group and is driven through the camshaft gear. The hydraulic pump is used on precise generator sets only. The hydraulic pump is a positive displacement gear type pump with a built in adjustable relief valve. The pump is coupled to the pump drive group by means of a tang type drive coupling. The pump consists of a shaft, dual gears, sleeve bearing, and seal.

### 8-94. REMOVAL.

[illegible] to figure 8-20 and remove hydraulic pump in order of index numbers assigned. Pay particular attention to the following.

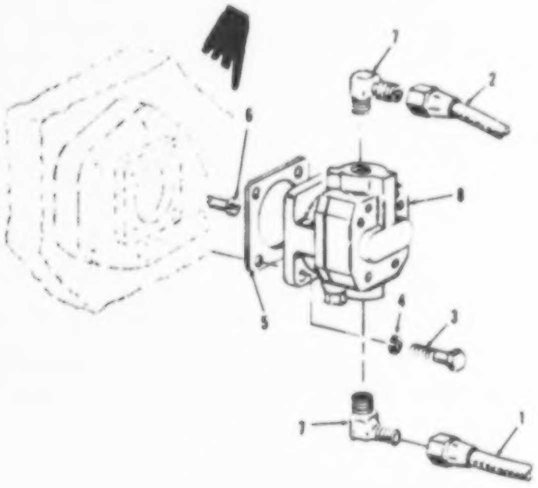

Figure 8-20. Hydraulic pump, removal and installation (precise sets only)

a. Disconnect hose assemblies (1 and 2) from pump suction and discharge ports, and plug hose assemblies to prevent fluid spillage.

b. When removing pump assembly (8) from pump drive, hold hand under adapter flange on pump drive to catch coupling shaft (6) when it drops out.

### 8-95. CLEANING.

Wash pump assembly in an approved solvent to remove grease, and hydraulic fluid residue. Dry with a lint-free cloth.

### 8-96. INSPECTION.

a. Check pump shaft for freedom of rotation.

b. Inspect coupling shaft (6) for nicks and burrs on tang end.

c. Inspect condition of threaded holes in suction and discharge ports.

d. Discard gasket.

Legend to figure 8-20:

1. Hose assembly (suction)
2. Hose assembly (discharge)
3. Bolt (4)
4. Washer (4)
5. Gasket
6. Coupling shaft
7. Fitting (2)
8. Pump assembly

## 8-97. REPAIR.

### CAUTION

**Do not use a grinding wheel on coupling shaft tang.**

**a. Remove nicks and burrs on drive tang of coupling shaft using a suitable file.**

b. Damaged threads on suction and discharge ports may be retaped with a 1/2 inch (12.7 mm) N. P. T. F. tap. Flush pump with clean hydraulic fluid to remove cuttings after retapping.

## 8-98. HYDRAULIC PUMP TEST AND ADJUSTMENT (ON PRECISE GENERATOR SETS ONLY).

**Test and adjust the hydraulic pump as follows:**

### NOTE

**Rotation of pump is clockwise as viewed from drive end.**

**a. Connect hydraulic pump drive shaft to suitable vary-drive capable of 0 to 2500 RPM.**

**b. Connect supply line of suitable hydraulic test stand to IN port of pump. Pump should have fluid reservoir mounted higher than pump inlet.**

### NOTE

**Test stand should have an adjustable restriction valve in return line after flow meter.**

c. Connect a suitable 0 to 500 PSI (0 to 35.153 kg/sq cm) gauge and throttling valve to OUT port of pump. Connect out port of throttling valve to test stand flow meter.

d. Open throttling valve and test stand restriction valve. Start vary-drive and adjust speed to 1500 to 2116 RPM. Slowly close throttling valve and observe gauge reading. With valve fully closed, gauge should indicate 320 ± 10 PSI (22.498 ± .7031 kg/sq cm). If not, remove relief valve cap located next to pump IN port. Adjust relief valve to obtain 320 ± 10 PSI (22.498 ± .7031 kg/sq cm). Open throttling valve and permit approximately one gallon to flow through valve. Close valve and check gauge, reading should be 320 ± 10 PSI (22.498 ± .7031 kg/sq cm). If not, readjust relief valve. Install relief valve cap after adjustment is made.

e. Open throttling valve. Slowly close test stand restriction valve until a flow of 2 GPM (7.57 LPM) is indicated on flow meter. Check gauge, reading should be 320 ± 10 PSI (22.498 ± .7031 kg/sq cm).

f. Remove pump from test equipment. Replace pump that does not provide a minimum of 2 GPM (7.57 LPM) at 320 ± 10 PSI (22.498 ± .7031 kg/sq cm).

## 8-99. INSTALLATION.

**Refer to figure 8-20 and reassemble hydraulic pump in reverse order of index numbers assigned. Pay particular attention to the following.**

**a. Apply a small amount of grease to pump shaft end and engage coupling shaft. Grease will prevent coupling shaft from dropping when installing pump.**

**b. Position pump so that relief valve is pointing down.**

**c. Rotate shaft with fingers to position tang drive to mate with coupling shaft tang.**

### CAUTION

**Do not force pump onto drive flange.**

**d. Pump must seat squarely on drive flange.**

## Section XIV. HYDRAULIC PUMP DRIVE GROUP

### 8-100. GENERAL.

The hydraulic pump drive group is mounted to the flywheel housing and is gear driven from the accessory drive. It is utilized on precise generator sets only. The hydraulic pump drive group consists of a shaft, a gear, bearings, a seal and gaskets. The hydraulic pump drive group drives the hydraulic pump.

### 8-101. REMOVAL.

a. Refer to paragraph 8-94 and remove hydraulic pump (precise generator sets only).

b. Refer to figure 8-21 and remove the hydraulic pump drive group by removing bolts (5 and 8), nuts (6 and 9), lock washers (7 and 10), and gasket (19).

### 8-102. DISASSEMBLY.

Refer to figure 8-21 and disassemble hydraulic pump drive group in the order of index numbers assigned. Pay particular attention to the following:

a. When removing adapter (11), note position of drain hole to ensure correct positioning during reassembly.

b. If necessary, remove gears (28 and 31) and bearings (27 and 34) from shafts (44 and 38) using a suitable arbor press.

### 8-103. CLEANING.

CAUTION

Do not spin dry bearings.

Clean all parts with an approved cleaning solvent and air dry. Dry bearings with low pressure compressed air.

### 8-104. INSPECTION.

a. Check bearings for freedom of rotation. Replace a bearing if its rotation is rough.

b. Inspect bearings for pits, scratches, cracks, or chipped races.

c. Inspect drive gear teeth for nicks, burrs, cracks, and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of the gear.

d. Inspect drive gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

e. Inspect adapters for cracks. Replace cracked adapter.

f. Inspect adapter mounting surfaces and shaft for nicks and burrs.

g. Inspect threaded holes for threaded damage.

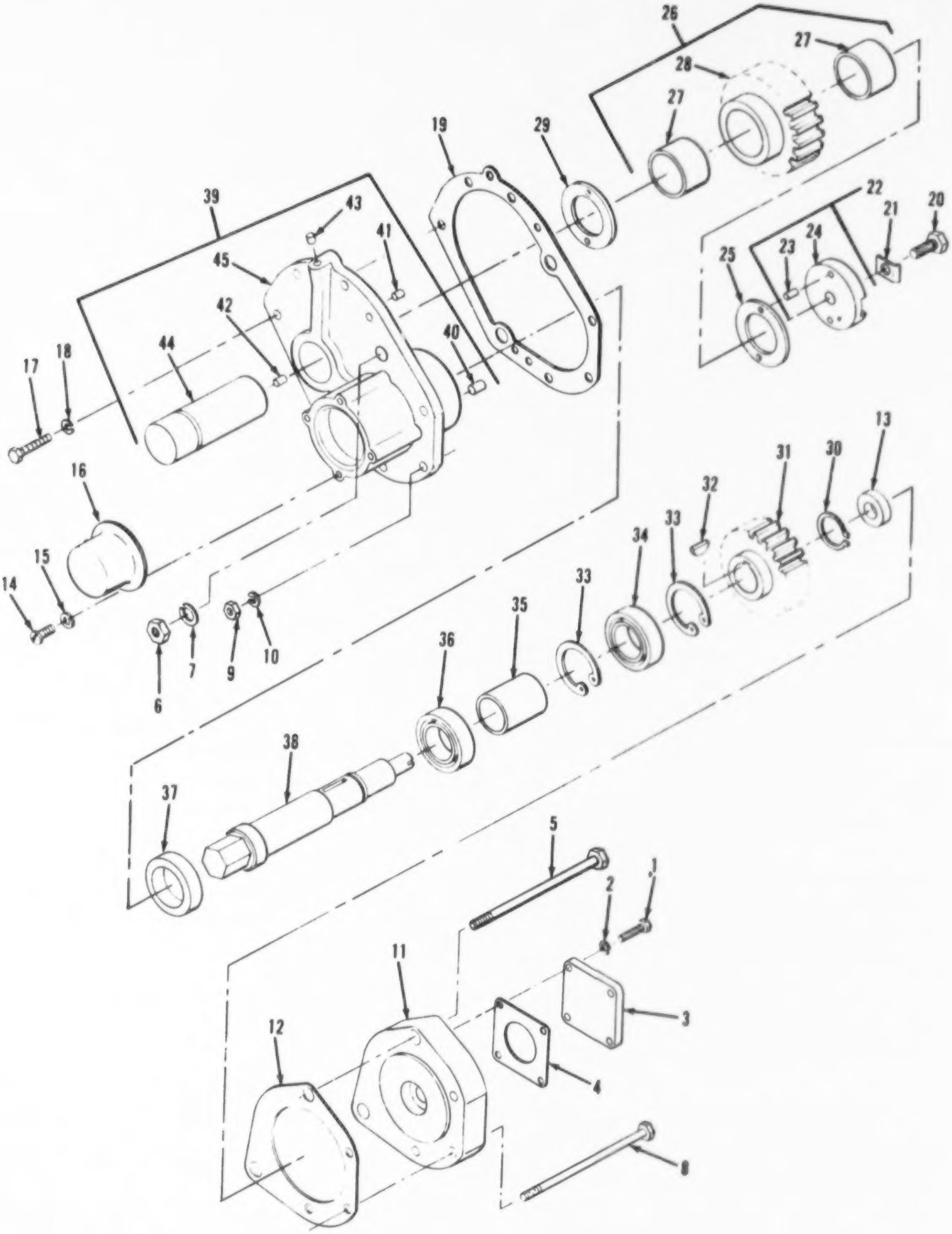
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Figure 8-21. Hydraulic pump drive group, exploded view

Legend to figure 8-21:

1. Bolt (4)
2. Lock washer (2)
3. Cover
4. Gasket
5. Bolt (2)
6. Nut (2)
7. Lock washer (2)
8. Bolt (3)
9. Nut (3)
10. Lock washer (3)
11. Adapter
12. Gasket
13. Seal
14. Screw (4)
15. Washer (4)
16. Cover
17. Bolt (3)
18. Lock washer (3)
19. Gasket
20. Bolt
21. Lock
22. Washer assembly
23. Dowel (2)
24. Washer
25. Washer
26. Gear assembly
27. Bearing (2)
28. Gear
29. Washer
30. Ring
31. Gear
32. Key
33. Ring (2)
34. Bearing
35. Spacer
36. Bearing
37. Seal
38. Shaft
39. Cover assembly
40. Dowel (2)
41. Dowel (2)
42. Dowel
43. Dowel
44. Shaft
45. Cover

h. Discard seal, gasket, and lock ring.

i. Check tang drive end of shaft. Slot in shaft should be 0.253 to 0.257 inch (6.426 to 6.527 mm) wide. Replace shaft if slot is not within limits.

### 8-105. REPAIR.

a. Remove minor nicks and burrs using a suitable file or hone.

b. Repair minor thread damage using a suitable thread chaser.

### 8-106. REASSEMBLY.

Refer to figure 8-21 and reassemble hydraulic pump drive group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. If removed, install gears (28 and 31) and bearings (27 and 34) on shafts (44 and 38) as follows:

1. Hand pack bearings with an approved grease. Install bearing onto shafts.

2. Preheat gears to a maximum of 600°F.

3. Using a suitable arbor press, press gears onto shafts.

b. Lubricate seal lip of seal (13) with an approved lubricant before installing on shaft (38).

c. Locate oil drain hole in end adapter (11). Drain hole must be pointed downward when drive is mounted in gear cover.

### 8-107. INSTALLATION.

a. Refer to figure 8-21 and install the hydraulic pump drive group, secure with bolts (5 and 8), nuts (6 and 9), lock washers (7 and 10) and gasket (19).

b. Refer to paragraph 8-99 and install hydraulic pump (precise generator sets only).

## SECTION XV.

## HYDRAULIC ACTUATOR, SUMP AND FILTER REPAIR INSTRUCTIONS

### Section I. HYDRAULIC ACTUATOR (CLASS I, PRECISE SETS ONLY)

8-108. General.

The hydraulic actuator (figures 8-22 and 8-23 is part of the generator set electro-hydraulic governing system (para. 7-1 and 7-2) and is used to control the speed of the generator set. An error voltage sensed by the governor system control unit is magnetically amplified to control the poser to energize the solenoid of the hydraulic actuator, thus changing the high pressure input oil into a differential pressure across the piston. This is accomplished by a solenoid controlled teeter bar within the actuator that controls the position of the actuator piston.

8-109. Malfunction.

A malfunction of the hydraulic throttle actuator is usually indicated by engine shutdown or overspeed when the START-STOP-RUN switch is transferred from the START to the RUN position, frequency drift observed on the frequency meters, sluggish response to load changes, or no response to load changes. To isolate the malfunction, proceed as follows:

a. Check for 4-6 Vdc at test points AB and CD (see figures 1-4 and 1-5) of electric governor control unit (A and D are positive), with engine operating. If voltage at either point is approximately 15 volts, the malfunction is a result of an opening in an actuator valve coil, or connecting circuit.

b. Check that the throttle linkage (see figure 8-22) is not badly worn or disconnected. A worn linkage can cause sluggish response or drifting frequency. A disconnected or broken linkage can cause overspeed shutdown, or no response. Also check linkage for binding due to dirt or distortion.

c. Check condition of hydraulic filter and the level of hydraulic oil. Either a clogged or dirty filter or low oil level can reduce the hydraulic pressure required to operate the actuator.

d. Check pressure output of hydraulic actuator by removing plugs in ports A1 and A2 and inserting 0-400 psi (0 to 28.122 kg/sq cm) range gages. The pressure at each port should be 160 ± 25 psi (7.031 ± 1.757 kg/sq cm) and equal, with engine operating under manual control, with J6 disconnected, the pressure at port A3 should be 160 ± 30 psi (7.031 ± 1.406 kg/sq cm) and approximately 50 psi (3.515 kg/sq cm) higher than the pressure at port A1.

e. Check the transducer in the actuator for freedom of movement. The transducer must move freely for good response.

f. If any of the above examinations indicates that the actuator has failed, proceed with removal, disassembly and repair instructions.

8-110. Removal and Disassembly.

a. Clean all hydraulic fittings and couplings throughly to prevent contamination of system.

b. Remove drain plug on bottom of hydraulic sump and drain and discard hydraulic oil, (Refer to Operator and Organizational Maintenance Manual for draining procedures.)

c. Remove hydraulic actuator as illustrated in figure 8-22.

d. Remove four bolts securing bracket to actuator and remove bracket.

e. Disassemble actuator as illustrated in figure 8-23.

f. To remove connector (34) tag and unsolder all wires attached to connector.

8-111. Cleaning, Inspection and Repair.

a. Clean all parts thoroughly with cleaning solvent Federal Specification P-D-680 and dry thoroughly.

b. Inspect all parts for damage or defective condition.

c. Inspect ball joints and linkage for excessive wear.

d. Inspect actuator packing and piston for damage.

e. Replace all defective parts.

### 8-112. Reassembly and Installation.

a. Reassemble the hydraulic actuator as illustrated in figure 8-23.

b. Install set screw (37) in core assembly (40) finger tight. Then install locknut (36). Proceed with care.

c. When installing connector (13), locate keyway at 12 o'clock position. (see figure 8-23.)

d. When installing connector (34), locate keyway at 6 o'clock position, viewed from top of valve block (48). (See figure 8-23).

### 8-113. Actuator Valve and Piston Test.

a. See figure 8-24 to perform the valve and piston test.

b. Connect dc power supply (ps) and switch (S1) to J6 as illustrated. Connect voltmeter **(M1)**with resistor (R1) to pins A and B of J4.

c. Attach gage G1 and G2 as shown . Connect hydraulic power source (310 - 320 psi (21.796 to 22.498 kg/sq cm), 2 gpm) (7.5696 lpm) and gage G3 and provide a return line from port R to the hydraulic sump.

d. To adjust the valves, remove the large round cover and replace it with a similar diameter collar which will allow access to the adjustment screws and jam nuts. This is necessary to contain the hydraulic fluid which is ported within this cover.

e. With hydraulic power but no electric **power**, applied, adjust the valve with Allen set screw to yield 200 psi ± 10 psi (14.062 ± .703 kg/sq cm) at A1 port (gage G1) and 150 psi ±10 psi (10.546 ±.07031 kg/sq cm) at A2 port (gage G2). (See figure 8-24.)

CAUTION: Avoid overadjusting to prevent pressures or forces which could bend valve push rods.

f. After adjusting, lock Allen adjusting screws with jam nuts, and install cover.

g. Set S1 to the center position (solenoid coils in series). Apply 350 ± 20 ma through the coils. Pressures at A1 and A2 ports shall remain the same (para 13-6.e).

h. Set switch S1 to connect power (PS) to coil L2 and apply 700 ma ± 40 ma. Pressure at A1 port (gage G1) shall be 310 to 400 psi (21.795 to 28.122 kg/sq cm). pressure at A2 port (gage G2) shall be 0 to 20 psi (0 to 1.406 kg/sq cm).

i. Set switch S1 to connect power (PS) to coil L1 and apply 700 ma ± 40 ma. Pressure at A1 port (gage G1) shall be 0 to 40 psi (0 to 2.812 kg/sq cm) and pressure at A2 port (gage G2) shall be 310 to 400 psi (21.795 to 28.122 kg/sq cm).

### 8-113A Throttle Position Transducer Test.

a. With voltmeter (M1), resistor (R1) and 120 (± 1% 60 Hz) power source connected as shown in figure 8-24, move piston to fully open throttle position.

b. With the transducer body locked in place by its set screw, loosen the transducer core set screw and move the core relative to the body until a minimum voltage (0.5 to 2.5 volts) is obtained on the transducer secondary, as indicated on M1.

c. Move the piston gradually towards the fully closed throttle position. The transducer secondary voltage, indicated by meter M1 shall increase in a linear manner to a maximum of 48 to 55 volts.

d. Repeat these adjustments until the transducer secondary voltage increases linearly from the lowest possible value to a maximum value over the entire 1.0 inch (25.40 mm) displacement of the piston.

e. When final adjustment is made, lock the transducer core in place with the transducer core set screw.

f. Remove the gages, meter, and power supplies.

8-114. Installation.

a. Install the hydraulic actuator with attaching hardware (fig. 8-22).

b. Connect hydraulic pressure and return lines to the actuator pressure and return parts. Different line sizes prevent inadvertent crossing of lines. (fig. 8-23).

c. Connect electrical connectors J24 and J25. Electrical connectors cannot be interchanged due to differing number of pins. (fig. 8-23).

d. Attach rod-ends. Shaft and clevis.

e. Adjust the linkage in accordance with para. 8-115.

8-115. Throttle Linkage Adjustment.

a. Place the Stop-Run-Start switch in the RUN position. (DO NOT start the set.)

b. Place the battle short switch in the OVER-RIDE or UP position.

c. Remove the bolt connecting the linkage rod to the fuel injection pump shut-off arm.

d. Starting at the full counter clockwise position, move the fuel injection pump shut-off arm clockwise until a slight resistance is felt. When this resistance is felt, hold the shut-off arm in that position.

NOTE

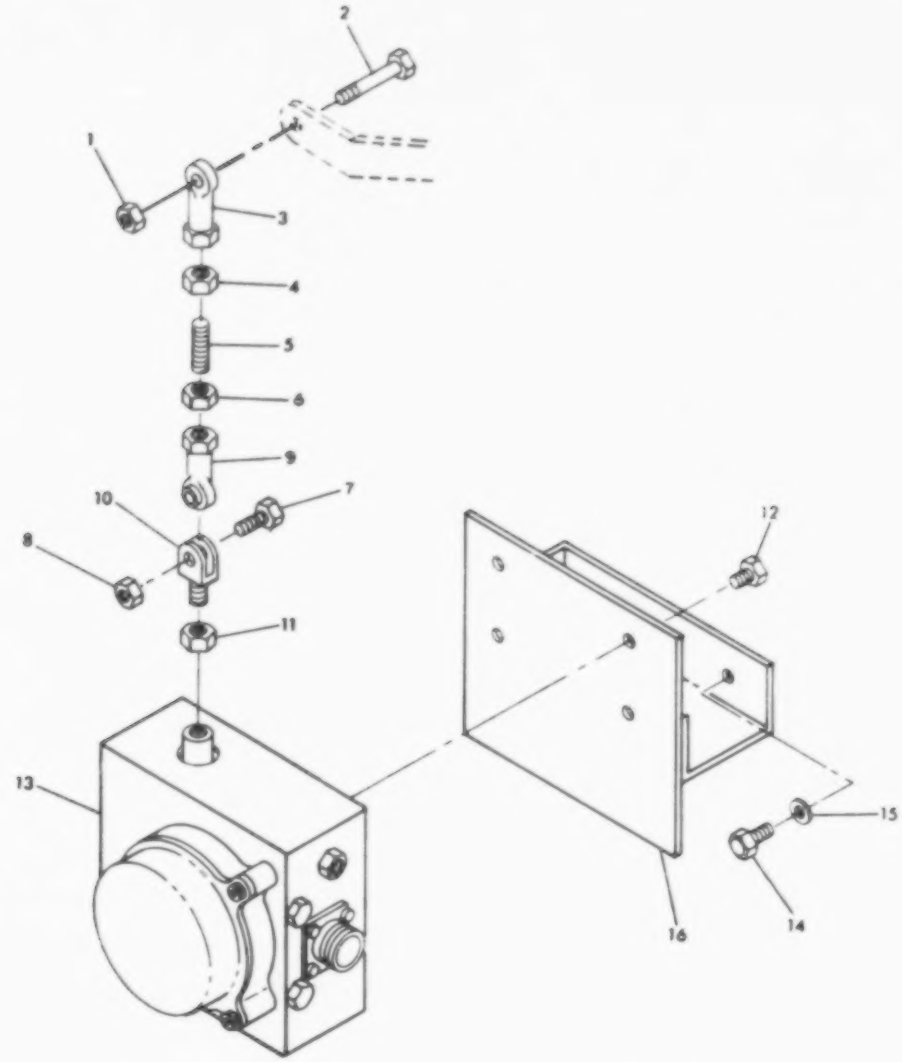
> This resistance is the fuel injection pump linkage coming into contact with the arm which moves the metering valve and starts in the direction of no fuel.

e. Move the actuator piston to the full OPEN (DOWN) position.

f. Make the necessary adjustment to the linkage rod, such that it will fit between the actuator piston and the fuel injection pump shut-off arm.

g. Start the generator set. Refer to the Operator and Organizational Maintenance Manual.

h. Observe the frequency meter on the panel in the control cubicle.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| | |
|---|---|
| 1. Nut | 9. Rod end |
| 2. Screw | 10. Clevis |
| 3. Rod end | 11. Nut |
| 4. Nut | 12. Screw |
| 5. Rod | 13. Hydraulic actuator |
| 6. Nut | 14. Screw |
| 7. Screw | 15. Washer |
| 8. Nut | 16. Bracket |

Figure 8-22. Hydraulic Actuator and Related Parts

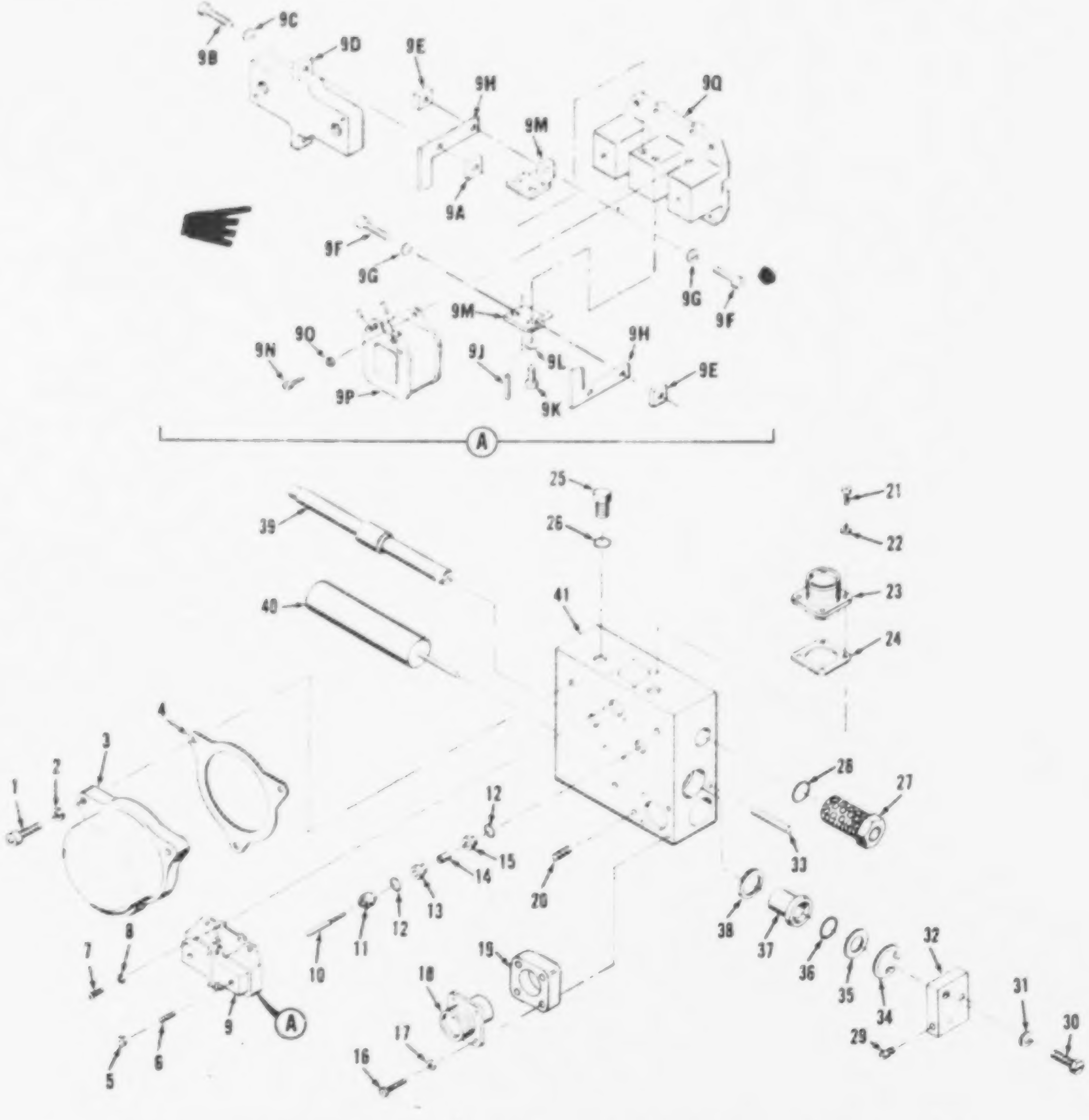
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Figure 8-23. Governor actuator unit, exploded view (precise sets only)

Legend to figure 8-23

1. Screw (3)
2. Lock washer (3)
3. Cover
4. Gasket
5. Nut (2)
6. Setscrew (2)
7. Screw (2)
8. Lock washer (2)
9. Coil and armature assembly
9A. Nut (2)
9B. Screw (2)
9C. Lock washer (2)
9D. Armature
9E. Nut (2)
9F. Screw (2)
9G. Lock washer (2)
9H. Spring

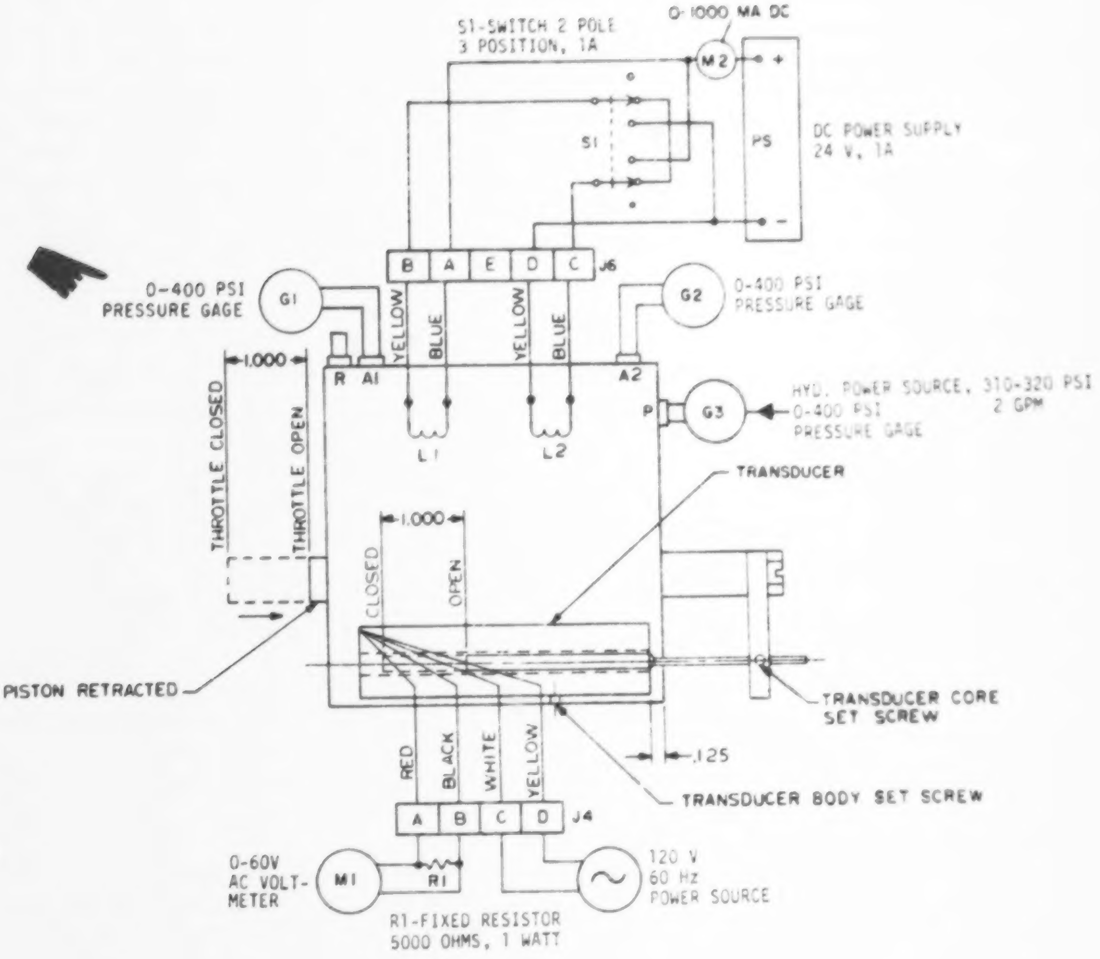

S1-SWITCH 2 POLE
3 POSITION, 1A
0-1000 MA DC
M2
+
S1
PS
DC POWER SUPPLY
24 V, 1A
-
B
A
E
D
C
J6
0-400 PSI
PRESSURE GAGE
G1
YELLOW
BLUE
YELLOW
BLUE
G2
0-400 PSI
PRESSURE GAGE
1.000
R
A1
A2
THROTTLE CLOSED
THROTTLE OPEN
P
G3
HYD. POWER SOURCE, 310-320 PSI
2 GPM
0-400 PSI
PRESSURE GAGE
L1
L2
TRANSDUCER
1.000
CLOSED
OPEN
PISTON RETRACTED
TRANSDUCER CORE
SET SCREW
RED
BLACK
WHITE
YELLOW
.125
TRANSDUCER BODY SET SCREW
A
B
C
D
J4
0-60V
AC VOLT-
METER
M1
R1
120 V
60 Hz
POWER SOURCE
R1-FIXED RESISTOR
5000 OHMS, 1 WATT

Figure 8-24. Hydraulic Actuator Tests, Schematic Diagram

Legend to figure 8-23 (Cont.):

9J. Spring pin (4)
9K. Screw (4)
9L. Lock washer (4)
9M. Bracket (2)
9N. Screw (4)
9O. Lock washer (4)
9P. Coil assembly (2)
9Q. Core
10. Needle (2)
11. Top orifice (2)
12. Preformed packing (4)
13. Spacer
14. Valve (2)
15. Bottom orifice (2)
16. Screw (4)
17. Lock washer (4)
18. Receptacle
19. Gasket
20. Setscrew (2)
21. Screw (4)
22. Lock washer (4)
23. Receptacle
24. Gasket
25. Plug (2)
26. Preformed packing (2)
27. Filter assembly
28. Preformed packing
29. Setscrew
30. Bolt
31. Lock washer
32. Link
33. Roll pin
34. Retaining ring (2)
35. Washer (2)
36. Preformed packing (2)
37. Collar (2)
38. Quad-ring (2)
39. Piston
40. Transducer assembly
41. Drive screw (4)
42. Identification plate
43. Transducer body

d. Top orifice (11) is removed by pulling directly upward.

## 8-111. CLEANING.

CAUTION

Do not immerse armature and coil assembly in solvent.

a. Wash all governor actuator parts except armature and coil assembly in an approved cleaning solvent. Use low pressure compressed air to dry parts or a lint free cloth.

b. Clean armature and coil assembly with a cloth moistened with an approved cleaning solvent and dry with a clean lint free cloth.

c. Clean electrical connector sockets and test jacks with low pressure, compressed air.

## 8-112. INSPECTION.

a. Inspect piston (39) for scoring or scuff marks. Inspect for nicks or burrs or edge diameters in the center section of the piston.

b. Inspect top orifice (11), spacer (13) and bottom orifice (15) for nicks and burrs. Inspect 3 cornered valve (14) for nicks and burrs on vertical edges that could cause binding. Inspect depth of needle hole in top of valve. Hole should be at least 0.125 inch in depth. Inspect bottom of valve (end opposite the needle hole) for indications of grooving.

c. Using a suitable feeler gauge, check the air gap on the armature and coil assembly (9). Air gap should be 0.030 to 0.038 inch for each coil.

d. Inspect the condition of the filter mesh in the filter assembly (27) for breaks or oversize holes in the mesh screen. Inspect the solder joint securing the mesh screen to inlet port body.

e. Inspect receptacles (18 and 23) for broken pins and locating keys. Replace defective receptacle.

f. Inspect all tapped holes in transducer body for nicks or otherwise damaged threads.

g. Roll pin (33) when pressed into transducer body (41) must extend a minimum of 1 3/8 inches from the transducer body (41).

h. Discard all packings and gaskets.

## 8-113. REPAIR.

a. Most repair work consists of polishing of parts. Use No. 320 to 500 fine grit emery cloth for polishing all moving parts. Clean after polishing with approved solvent and dry thoroughly.

b. Damaged threads can be cleaned up using the proper size pipe tap to remove burrs.

### CAUTION

Under no condition use a file on this valve surface, its length is critical.

c. The valves (14) may be polished to remove nicks and burrs or slight groove marks on the bottom of the valve. If after polishing the lower face the overall length of the valve is less than 0.240 inch, replace the valves (14).

d. The filter assembly (27) may be repaired by soldering if screen mesh has broken loose from the port body. Do not attempt to solder up broken areas in the screen mesh.

## 8-114. REASSEMBLY.

Refer to figure 8-23 and reassemble governor actuator unit in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Coat piston (39) with clean hydraulic oil conforming to Military Specification MIL-H-5606, prior to reassembly.

b. If receptacle (23) had to be removed due to armature and coil assembly (9) replacement, reconnect coil leads to receptacle L1 and L2 coils as shown in figure 8-24 as they are located when transducer body of actuator unit is positioned like that shown in figure 8-24.

c. When inserting transducer assembly (40, figure 8-23) in transducer body (41), refer to figure 8-24 for location of transducer body and position of core in relation to transducer body (41). This dimension is critical.

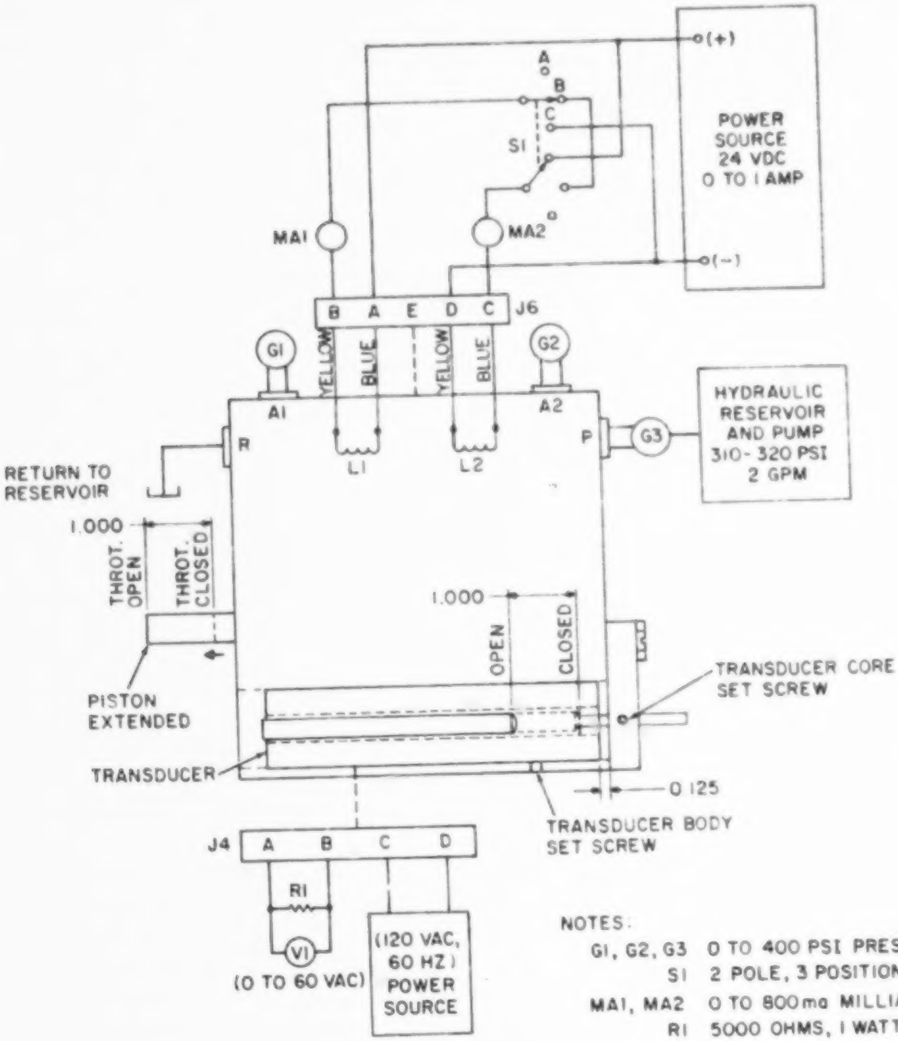
d. After core is positioned in transducer body, tighten set screw (29) in link (32) to secure core control arm.

## 8-115. TEST AND ADJUSTMENT.

a. Test equipment required.

1. Hydraulic pump (310 to 320 psi at 2 GPM).
2. Power source (120V 60 Hz).
3. D.C. power source (0 to 1 AMP 24 V.D.C.).
4. Switch, 2 pole, 3 position, 1 amp rating.
5. Meter (2) (0 to 800 ma).
6. Meter (1) (0 to 60 volts A.C.).
7. Resistor (fixed - 5000 ohms, 1 watt).
8. Gauge (3) (pressure 0 to 400 psi).

b. Actuator Valve and Piston Test. Connect the governor actuator unit to test


(+)
A
B
C
S1
POWER SOURCE 24 VDC 0 TO 1 AMP
MA1
MA2
(−)
J6
B A E D C
YELLOW
BLUE
YELLOW
BLUE
G1
G2
A1
A2
L1
L2
R
P
G3
HYDRAULIC RESERVOIR AND PUMP 310-320 PSI 2 GPM
RETURN TO RESERVOIR
1.000
THROT. OPEN
THROT. CLOSED
1.000
OPEN
CLOSED
PISTON EXTENDED
TRANSDUCER CORE SET SCREW
TRANSDUCER
0.125
TRANSDUCER BODY SET SCREW
J4
A B C D
R1
V1
(0 TO 60 VAC)
(120 VAC, 60 HZ) POWER SOURCE

NOTES:

| | |
|---|---|
| G1, G2, G3 | 0 TO 400 PSI PRESSURE GAUGES |
| S1 | 2 POLE, 3 POSITION, 1 AMP SWITCH |
| MA1, MA2 | 0 TO 800ma MILLIAMMETER |
| R1 | 5000 OHMS, 1 WATT |

Figure 8-24. Governor actuator unit, test and adjustment

equipment as illustrated in figure 8-24 and proceed as follows:

1. With 24 vdc supply off, turn on the hydraulic pump drive and adjust the pressure to port P until G3 indicates 320 ± 10 psi. Adjust pressure by setting the relief valve in the pump, refer to paragraph 8-89.

NOTE

The actuator output shaft shall be in the fully extended position (throttle open). Gauge G1 shall indicate 150 ± 10 psi. Gauge G2 shall indicate 200 ± 10 psi.

2. If gauges G1 and G2 do not indicate the required pressures, adjustment of valve screws (6, figure 8-23) on the armature and coil assembly (9) will have to be made. Proceed as follows.

(a) Remove cover (3) figure 8-23 and place the governor actuator in a catch pan. The catch pan should drain back to the reservoir.

(b) Loosen lock nuts (5, figure 8-23) on each valve adjustment screw (6).

(c) To adjust pressure at gauge G1, insert an allen wrench in screw (6) on coil L1 adjustment screw (6) and rotate clockwise (or in) to reduce pressure on gauge G1. Rotating screw (6) counterclockwise will increase pressure on G1.

(d) Adjust pressure at gauge G1 by rotating screw (6) on coil L2 in the same manner as pressure adjustment on coil L1 was performed.

NOTE

Adjustment of one side (L1) will in some degree effect the opposite side (L2); therefore, several adjustments of both sides will be required to obtain the setting specified in step c.

(e) Tighten lock nuts (5).

(f) Turn power supply on and position switch S1 to B and adjust 24 vdc power source until MA1 and MA2 indicate 350 ± 20 ma. The actuator output shaft shall remain in the extended position. Gauge G1 shall indicate 150 ± 10 psi. Gauge G2 shall indicate 200 ± 10 psi.

(g) Position switch S1 to A. Adjust 24 vdc power supply until MA2 indicates 700 ± 40 ma. Piston shall fully retract. Gauge G1 shall indicate 310 to 400 psi. Gauge G2 shall indicate 0 to 20 psi.

(h) Position switch S1 to C. Adjust 24 vdc power supply until MA1 indicates 700 ± 40 ma. Piston shall fully extend. Gauge G1 shall indicate 0 to 40 psi. Gauge G2 shall indicate 310 to 400 psi.

c. Actuator Output Shaft Position Transducer Test and Adjustment. Connect voltmeter V1 and power sources to receptacle J4 on actuator as illustrated in figure 8-24 and proceed as follows:

NOTE

Hydraulic system components are not used during this test.

CAUTION

The output shaft position transducer is factory aligned and does not normally require readjustment.

1. Turn on the power supply.

2. Move the actuator output shaft to fully extended position. Transducer assembly (40, figure 8-23) locked in place at dimensions indicated in figure 8-24. V1 shall indicate 0.5 to 2.5 volts. This shall be minimum voltage regardless of what other position the output shaft is placed.

3. If voltage range on V1 is not with the required 0.5 to 2.5 volts, loosen transducer core set screw (29, figure 8-23) on link (32) and move the core relative to the body until the minimum voltage of 0.5 to 2.5 is obtained on meter V1. Adjust to 1 volt as a starting point. Tighten the set screw (29) in place.

d. Move the piston (39) gradually towards the fully closed throttle position.

The transducer secondary voltage shall increase in a linear manner to a maximum of 48 to 55 volts. Loosen set screw (29) and adjust to 50 volts as a starting point. Repeat core adjustment until the transducer secondary voltage increases linearly from the lowest possible value to a maximum value over the entire 1.0 inch travel of the piston (39). The ideal voltage range would be from 0.5 volt minimum to 55 volts maximum. This range may not be possible to obtain so the widest voltage spread will be acceptable as long as the minimum and maximum voltages are within the specified limits.

e. Tighten transducer core set screw (29).

## 8-116. INSTALLATION.

Refer to figure 8-22 and install precise governor actuator in reverse order of index numbers assigned. Pay particular attention to the following.

a. Before connecting actuator clevis to linkage, rotate fuel injection pump lever to maximum throttle position and scribe an indicating mark for reference. Then rotate fuel injection pump lever to minimum throttle position and scribe an indicating mark for reference.

NOTE

Fill FUEL POSITION on pump lever is when top of lever is pushed towards front of engine.

b. Install actuator on mounting plate and secure with four mounting bolts.

c. Connect hydraulic and electrical connections.

d. Align actuator clevis hole with hole in linkage.

e. Loosen bolts securing pin bracket and slide bracket forward. Pass pin through clevis and pin bracket. Then tighten bolts and secure clevis to pin with cotter pin.

f. Check that actuator output shaft can move fuel inspection pump lever from full throttle to closed throttle position according to the scribe marks.

g. If full operating range cannot be reached, refer to linkage adjustment procedure in the Operator and Organizational Maintenance Manual.

## Section XVI. WATER PUMP GROUP

### 8-117. GENERAL.

The water pump is mounted on the flywheel housing. The centrifugal-type pump is driven by the crankshaft through a cluster gear. The pump consists of an impeller and drive gear mounted on a common rotating shaft. Seals mounted on the shaft prevent water from leaking into the gear section and oil from leaking into the impeller section. As the engine is running, the drive gear in the water pump turns the shaft and impeller. The impeller creates a forceful flow of water through the engine cooling system.

### 8-118. REMOVAL.

Refer to Operator and Organizational Maintenance Manual, and remove water pump.

### 8-119. DISASSEMBLY.

Refer to figure 8-25, and disassemble water pump in the order of index numbers assigned. Pay particular attention to the following:

a. Using a suitable puller remove gear (9) from shaft (38).

b. Install two 3/8-16 NC forcing screws, 180 degrees apart in cover (15) and separate cover (15) from housing (41).

c. Back nut (19) off flush with end of shaft (38). Using a suitable puller separate impeller (21) from shaft (38).

d. Place a nut on end of shaft (38) to protect threads. Press bearings (35 and 36) and shaft (38) out of housing (41) as an assembly.

e. Press out seal (39) and seal assembly (24) from housing (41).

f. Press bearings (35 and 36) and spacer (37) off shaft (38).

### 8-120. CLEANING.

a. Clean all metal parts with an approved cleaning solvent and dry thoroughly.

b. Clean calcium deposits from housing using a stiff wire brush.

c. Remove all traces of old gasket material from gear cover.

### 8-121. INSPECTION.

a. Check bearings for freedom of rotation. Replace a bearing if its rotation is rough.

b. Inspect bearings for pits, scratches, cracks or chipped races. Replace defective bearing.

c. Inspect shaft for nicks, burrs, pits or cracks. Replace defective shaft.

d. Inspect threaded parts for thread damage.

e. Inspect impeller for nicks, burrs, erosion, or cracks. Replace erroded or cracked impeller.

f. Inspect cover and housing for cracks. Replace defective parts.

g. Inspect gear teeth for nicks, burrs, cracks and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of the gear.

h. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

i. Discard seals and gaskets.

## 8-122. REPAIR.

a. Remove minor nicks and burrs using a suitable file or hone.

b. Repair minor thread damage using a suitable thread chaser.

## 8-123. REASSEMBLY.

Refer to figure 8-25, and reassemble water pump in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Press bearing (35 and 36) and spacer (37) onto shaft (38).

b. Press bearings (35 and 36) and shaft (38) into housing (41).

c. Wrap a thin sheet of plastic or metal around shaft (38). Lubricate lip of seal (39) with clean SAE 30 engine oil. Slide seal (39) over shaft (38) with lip of seal facing bearing (36). Using a suitable arbor press, install seal (39) into bearing cage.

d. Press seal assembly (24) into housing (41).

e. Torque nut (19) to 55 foot pounds.

f. Install cover (15) without seal (14) and gaskets (16).

g. Using a feeler gauge, measure clearance between cover (15) and impeller (21). Add gaskets (16) as required to obtain 0.005 to 0.020 inch clearance. Remove cover (15) and install seal (14). Install cover (15) and recheck clearance.

h. Preheat gear (9) in oil to 300°F and press gear onto shaft (38). Torque nut (7) to 60 foot pounds.

## 8-124. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual, and install water pump group.

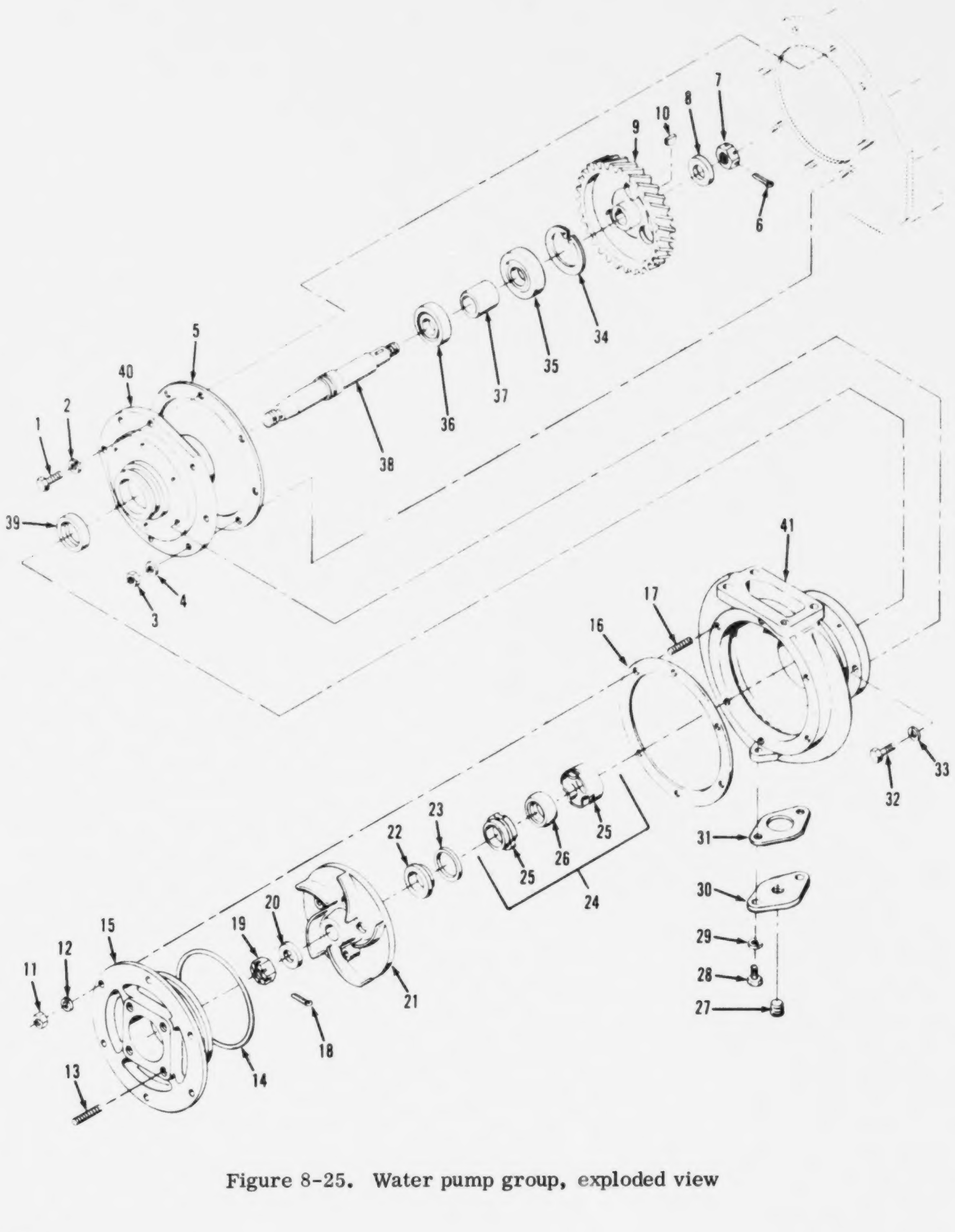

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Figure 8-25. Water pump group, exploded view

Legend to figure 8-25:

1. Bolt (3)
2. Lock washer (3)
3. Nut (5)
4. Lock washer (5)
5. Gasket
6. Cotter pin
7. Nut
8. Washer
9. Gear
10. Key
11. Nut (6)
12. Lock washer (6)
13. Stud (4)
14. Seal
15. Cover
16. Gasket
17. Stud (6)
18. Cotter pin
19. Nut
20. Washer
21. Impeller
22. Ring
23. Seal
24. Seal assembly
25. Washer
26. Bellows assembly
27. Plug
28. Bolt (2)
29. Lock washer (2)
30. Cover
31. Gasket
32. Bolt (6)
33. Lock washer (6)
34. Ring
35. Bearing
36. Bearing
37. Spacer
38. Shaft
39. Seal
40. Adapter
41. Housing

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## Section XVII. UTILITY GOVERNOR GROUP

### 8-125. GENERAL.

The utility governor group is made up of two major assemblies mounted on the right side of the engine, the hydraulic governor assembly and the governor drive assembly. The governor consists of a governor drive shaft, speed adjusting shaft, low speed and high speed stop screws, related linkages, and shutdown solenoid valve. The speed adjusting shaft is used to set the governor at the desired running speed. Low speed and high speed stop screws are provided to limit the speed range of the governor. The utility governor is mechanical-hydraulic type which senses engine speed by means of flyweights balancing against a speeder spring. This governor is designed to correct the fuel rate as a result of an off-speed condition only. On units equipped with the precise governor, the utility governor is adjusted to maintain an engine speed above the desired speed. Therefore, when the precise governor is controlling the engine, the utility governor will move to the position to deliver maximum fuel, while the precise governor controls the fuel rate so as to maintain the desired speed.

### 8-126. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual and remove manual speed control.

b. Remove governor actuator unit (precise sets only) (paragraph 8-109).

c. Remove hydraulic tank (precise sets only) (paragraph 8-86).

d. Refer to figure 8-26 and remove utility governor, linkage and oil lines in the order of index numbers assigned. Pay particular attention to the following:

NOTE

Prior to removal of the utility governor, make a note of the overall distance between the ball joint centers (4, 5, and 6) so that this rod assembly can be reinstalled at the same distance between ball joint centers.

1. Disconnect spring (40) from lever (34) and allow spring to hang.

2. Disconnect tube (22) from elbow (23) and move tube (22) enough for removal of tube (24).

3. Remove utility governor assembly (30) from governor drive prior to removal of lever (34).

4. Remove tube (22) and fitting (37).

e. Refer to figure 8-27 and remove governor drive housing in the order of index numbers assigned. Pay particular attention to the following:

1. Lift cover assembly (9) straight up to disengage spring (10).

2. Move plate (19) away from fuel injector pump assembly (21) so that pin assembly (16) can be seen.

3. Using a suitable tool rotate pin assembly (16), from flange (3) end of governor drive housing (17), until slot of pin assembly (16) is in the top position.

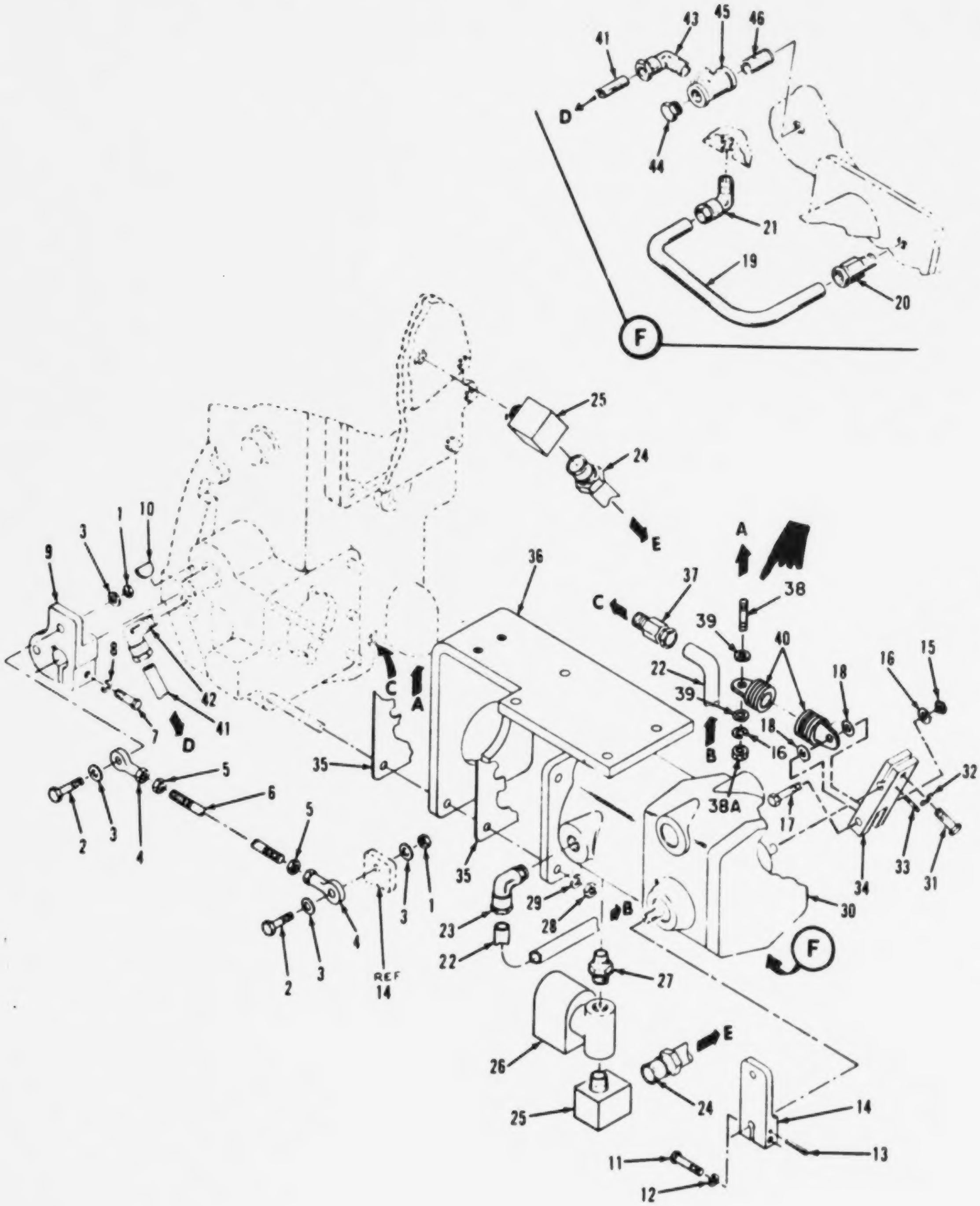
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Figure 8-26. Utility governor and linkage, exploded view

Legend to figure 8-26:

1. Nut (2)
2. Bolt (2)
3. Lock washer (2)
4. Rod end (2)
5. Nut, lock (2)
6. Rod
7. Bolt
8. Lock washer
9. Lever
10. Key
11. Bolt
12. Lock washer
13. Pin
14. Lever
15. Nut
16. Lock washer (2)
17. Bolt
18. Washer (2)
19. Tube
20. Fitting
21. Elbow
22. Tube
23. Elbow
24. Tube
25. Elbow
26. Solenoid valve
27. Coupling
28. Nut (4)
29. Lock washer (4)
30. Utility governor assembly
31. Bolt
32. Lock washer
33. Pin
34. Lever
35. Gasket (2)
36. Mounting Plate
37. Fitting
38. Stud

38A. Nut

39. Washer (2)
40. Spring
41. Tube
42. Elbow
43. Elbow
44. Plug
45. Fitting
46. Nipple

4. Lift governor drive housing (17) straight up and remove.

NOTE

For utility sets equipped with engine shutdown assembly, remove as shown in figure 8-26A

8-127. DISASSEMBLY.

a. Refer to figure 8-28 and disassemble utility governor assembly in the order of index numbers assigned. Pay particular attention to the following:

1. Clamp the governor lightly in a vise; vise jaws must grasp the base below the base ase joint on the sides under the terminal shaft.

2. Insert a 5/16 inch (7.938 mm) diameter rod in the opening left after removing shaft (13), and drive the other shaft (13) out.

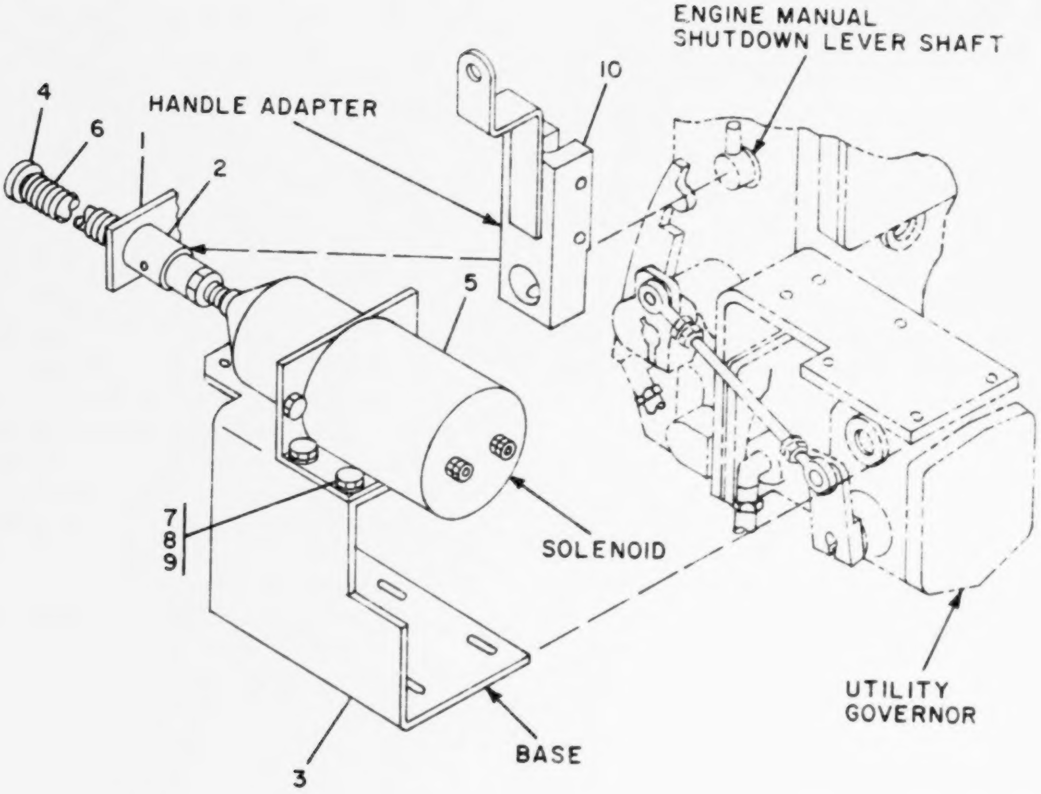
3. Make a note of the distance the high speed stop screw (19) protrudes from the case (69) so that it can be set approximately the same when reassembling.

4. Use a 1/8 inch (3.175 mm) diameter punch or rod to drive the pin (22) down from the top of lever (28) into the case (69).

5. Pull shaft (25) out of the case (69).

6. Lift out the assembly consisting of the lever (28), pilot valve plunger (49), bearing assembly (50), and connecting parts.

7. Remove plug (29), and gasket (30).


ENGINE MANUAL
SHUTDOWN LEVER SHAFT
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HANDLE ADAPTER
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GOVERNOR
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1. Stop bracket
2. Connector
3. Base
4. Screw
5. Solenoid
6. Spring
7. Screw
8. Lock washer
9. Flat washer
10. Handle adapter

Figure 8-26A. Engine Overspeed Shutdown Assembly

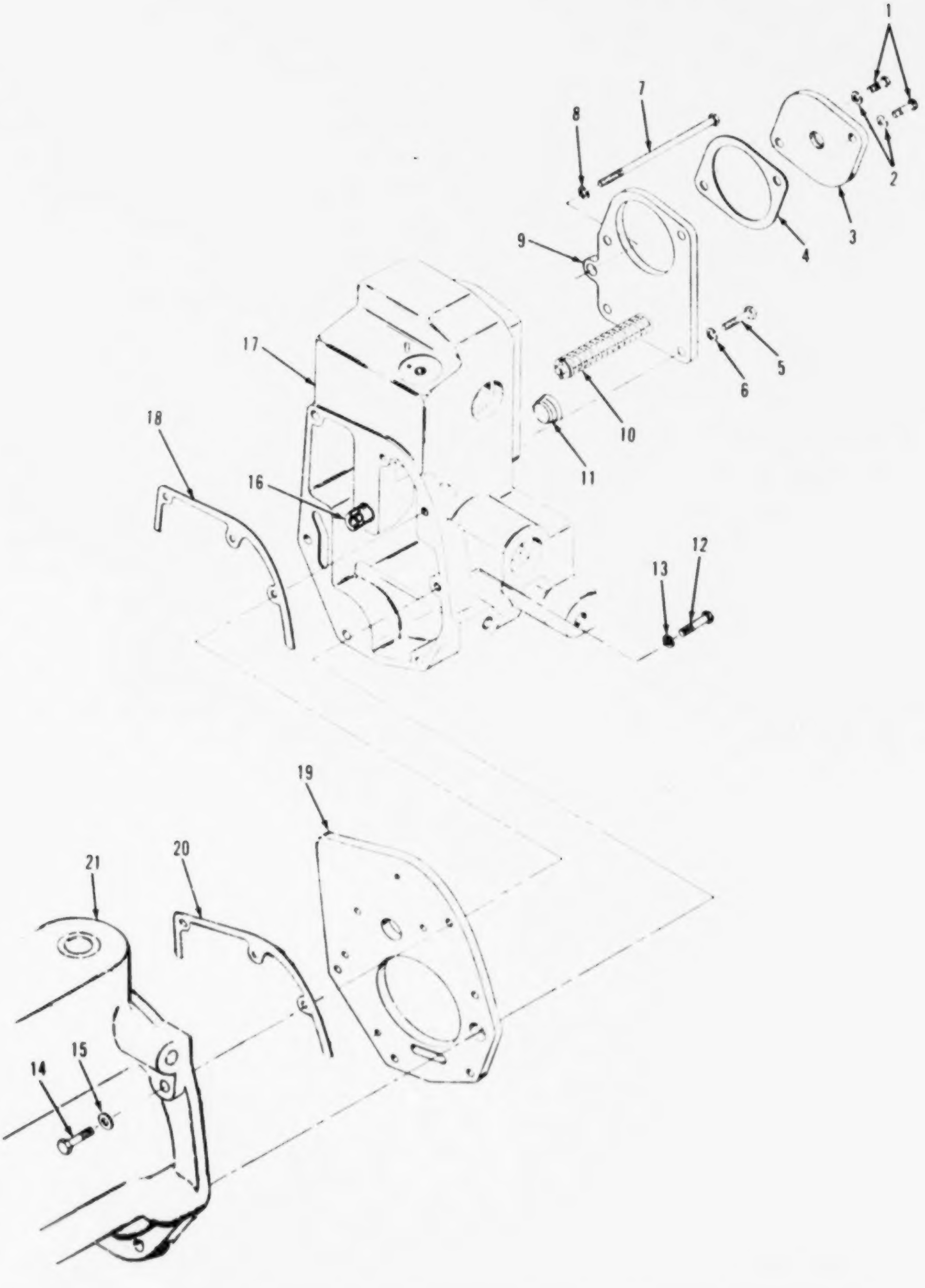
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Figure 8-27. Governor drive housing, removal and installation

Legend to figure 8-27:

1. Screw (2)
2. Lock washer (2)
3. Flange
4. Gasket
5. Screw (2)
6. Lock washer (2)
7. Screw
8. Lock washer
9. Cover assembly
10. Spring
11. Plug
12. Screw (5)
13. Lock washer (5)
14. Screw
15. Lock washer
16. Pin assembly
17. Governor drive housing
18. Gasket
19. Plate
20. Gasket
21. Fuel injection pump assembly

8. Remove springs (31 and 32).

NOTE

If the valve (33) and sleeve assembly (34) cannot be removed easily with a small pair of long-nosed pliers (or tweezers) and a hook scriber, leave them in the case (69) until step 14.

9. Remove the valve (33), and sleeve assembly (34).

10. Take the governor out of the vise and invert it, catching pin (39), piston (40), and rollpin (22) (driven out of the speed adjusting lever earlier).

11. Use snap ring pliers to take out the snap ring (53) under the ballarms. Lift out the ballhead assembly (57).

12. Remove snap ring (43) around the bushing assembly (54) drive shaft spline, and drive out bushing assembly (54) from base (62).

13. Remove screws (42) from the base (62) and remove the base (62). If the base (62) does not easily detach from the case (69), clamp base (62) (governor nameplate side of the case up) lightly in a vise; using a plastic or soft hammer, tap the underside of case (69) to loosen it from base (62).

CAUTION

Hold a hand under the base (62) and case (69) joint to catch the pump gears (58 and 59) which may drop out as the base (62) and case (69) are separated.

14. Remove pump gears (58 and 59) and gasket (61).

15. If the valve (33) and sleeve assembly (34) could not be removed in step 9, insert a 3/16 inch diameter rod in the tapped hole opposite the relief valve opening and push the valve (33) out. Then insert a suitable extracting tool in the relief valve opening to pull out the sleeve assembly (34).

16. Clamp stud (66) in a vise. Twist and pull case (69) to remove stud.

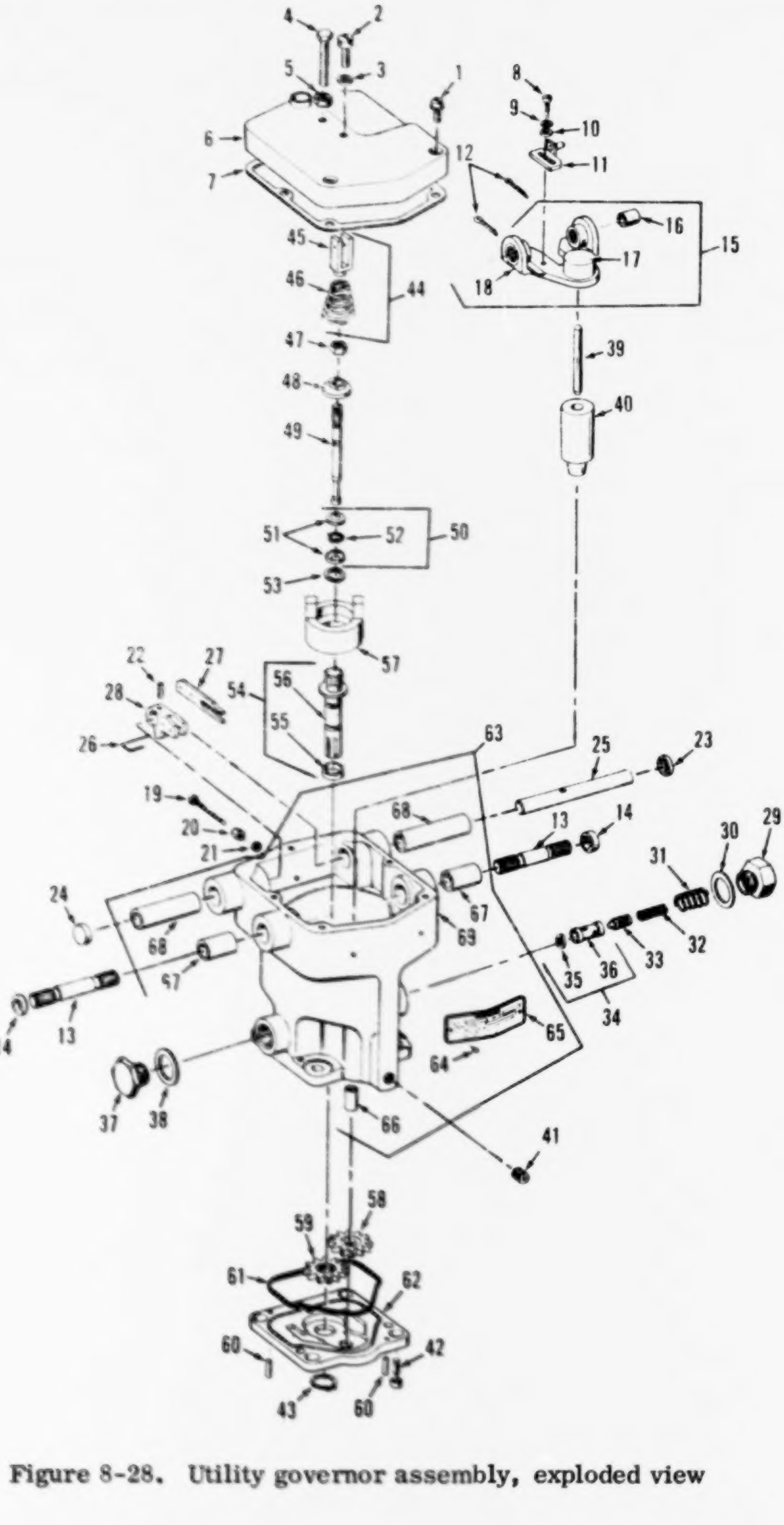
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Figure 8-28. Utility governor assembly, exploded view

Legend to figure 8-28:

1. Screw (3)
2. Screw
3. Washer
4. Screw
5. Nut
6. Cover
7. Gasket
8. Screw
9. Lock washer
10. Washer
11. Bracket
12. Cotter pin (2)
13. Shaft (2)
14. Seal (2)
15. Lever assembly
16. Bushing (2)
17. Cup
18. Lever
19. Screw
20. Nut
21. Washer
22. Roll pin
23. Seal
24. Plug
25. Shaft
26. Spring wire
27. Lever
28. Lever
29. Plug
30. Gasket
31. Spring
32. Spring
33. Valve
34. Sleeve assembly
35. Washer
36. Sleeve
37. Plug
38. Washer
39. Pin
40. Power piston
41. Plug
42. Screw (3)
43. Snap ring
44. Spring assembly
45. Fork
46. Spring
47. Nut
48. Spring retainer
49. Pilot valve
50. Bearing assembly
51. Race
52. Balls
53. Snap ring
54. Bushing assembly
55. Bushing
56. Shaft
57. Ball head assembly
58. Gear
59. Gear
60. Pin (2)
61. Gasket
62. Base
63. Case assembly
64. Screw (2)
65. Nameplate
66. Stud
67. Bushing (2)
68. Bushing (2)
69. Case

CAUTION

Be careful not to score the ground bottom surface of case (69).

17. If necessary, drive out bushings (67 and 68) using a 3/8 diameter rod and a suitable piloted driving block. In each instance drive the bushing (67 and 68) out of the case (69) (rather than in towards the center).

18. Clamp the fork (45) in a vise with a pin hole up; use a thin screwdriver or a small punch to drive the spring (46) off of the fork (45).

19. Twist the spring (46) to detach it from the spring seat.

b. Refer to figure 8-29 and disassemble governor drive housing in the order of index numbers assigned. Pay particular attention to the following:

1. If maximum fuel stop assembly (1 through 6) is not to be repaired it should not be disassembled.

NOTE

Insert a suitable spacer between lever (9) and housing (31) when removing lever to prevent damage to pin assembly.

2. Move shaft (11) away from housing (31) enough to remove lever (9). Push shaft (11) back to normal position and remove key (10). Remove shaft (11).

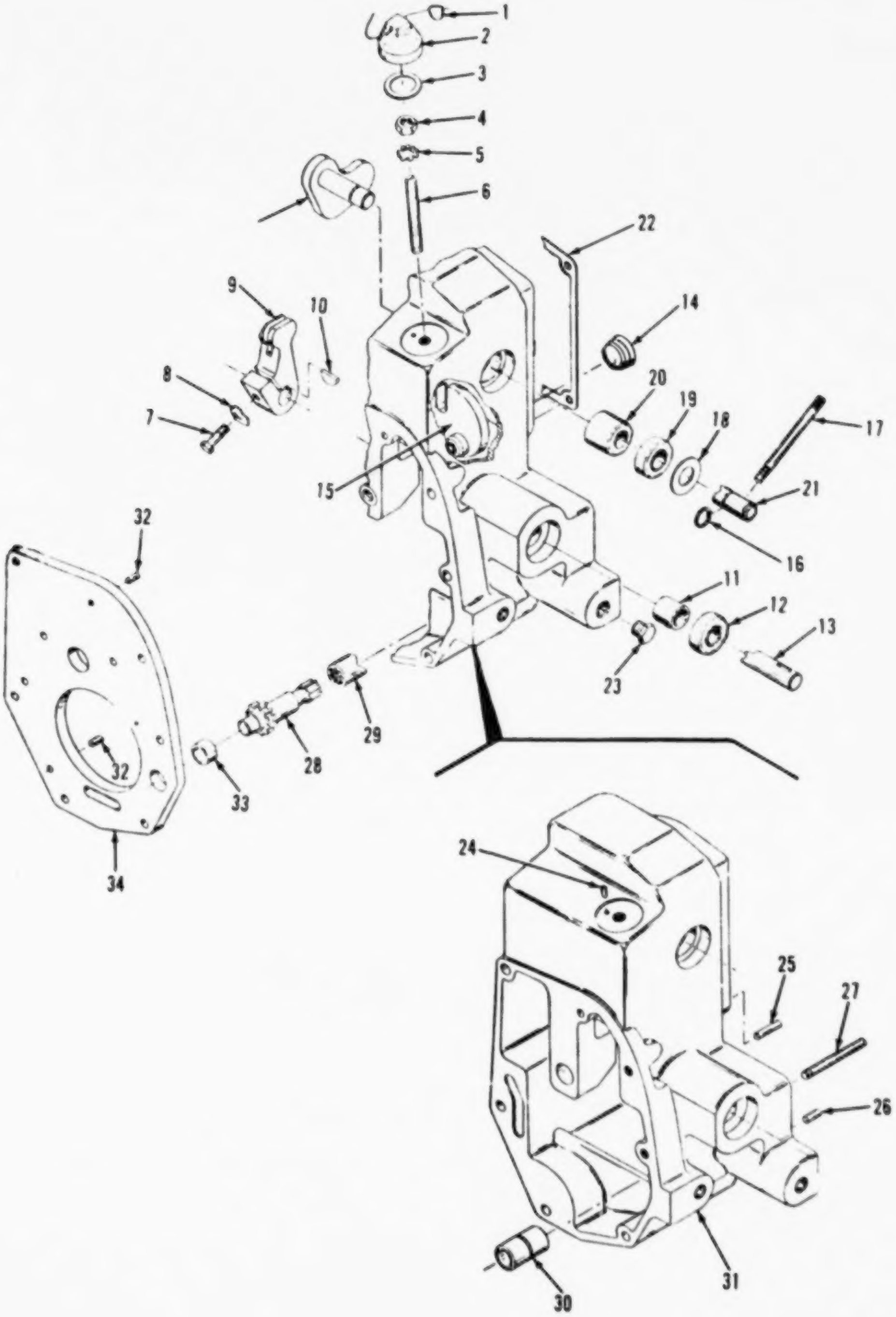
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Figure 8-29. Governor drive housing, exploded view

Legend to figure 8-29:

1. Safety wire
2. Cover
3. Washer
4. Nut
5. Lock
6. Screw
7. Screw
8. Lock washer
9. Lever
10. Key
11. Bearing
12. Seal
13. Shaft
14. Plug
15. Pin assembly
16. Ring
17. Stud
18. Washer
19. Seal
20. Bearing
21. Shaft assembly
22. Gasket
23. Plug
24. Pin
25. Pin
26. Pin
27. Stud
28. Gear
29. Seal
30. Bearing
31. Housing
32. Pin
33. Bushing
34. Plate

3. Use plug hole (14) to assist in removal of pin assembly (16). Compress spring by applying pressure on disc and slide pin assembly out from housing.

4. Seals (19 and 29) must be removed from the outside of the housing. Do not attempt to push towards center of housing.

## 8-128. CLEANING.

a. Utility governor.

1. Clean all parts in an approved cleaning solvent and dry with a lint free cloth.

### CAUTION

Use extreme care when polishing the pilot valve (49, figure 8-28) control land. Leave corners sharp; broken or rounded corners on this land will ruin the valve.

2. Polish parts using No. 320 to 500 fine grit emery cloth.

b. Governor drive housing. Clean all parts in an approved cleaning solvent and dry with a lint free cloth.

## 8-129. INSPECTION.

a. Utility governor.

1. Refer to table 1-1, and using a suitable micrometer, check the following parts for wear:

(a) Power piston (40, figure 8-28) O.D.

(b) Pilot valve (49) lands.

(c) Bushing (55) O.D.

(d) Shaft (56) spline end.

(e) Speed adjusting shaft (13) O.D.

(f) Terminal shaft (25) O. D.

(g) Idler gear stud (66).

(h) Drive gear (59) O. D.

(i) Relief valve (33) O. D.

(j) Replace parts that have exceeded maximum-allowable wear limits.

2. Inspect ground bottom surface of case (69) for grooves, scratches or wear.

3. Inspect the ground flat surface of the base (62) for warpage, nicks, or deep scratches.

4. Inspect the pump gears (58 and 59) as follows:

(a) Place the pump gears in the gear pockets and check for free rotation.

(b) If the gears turn roughly, inspect for nicks or wear of the gear teeth, and for interference at internal corners of the gear pockets in the base (62).

5. Check clearance between piston (40) and case (69), piston should move freely without binding or catching.

NOTE

Excessive clearance between piston (40) and case (69), however, will result in excessive oil leakage within the governor.

6. Inspect rod ends (4, figure 8-26) for freedom of movement of the ball within the housing socket. Replace rod ends that bind.

7. Inspect governor return spring (40, figure 8-26) for cracked coils and deformed end fittings. Replace defective springs.

8. Discard gaskets (7 and 61, figure 8-28).

b. Governor drive housing.

1. Inspect bushing (33 and 27, figure 8-29) for scoring, excessive wear, and other damage. Replace worn bushings.

2. Inspect drive gears (28) for excessively worn gear teeth.

3. Inspect shaft (13 and 21) for wear.

4. Discard gaskets (22) and seals (11 and 20).

## 8-130. REPAIR.

1. Most of the repair work consists of cleaning and polishing of parts. Use No. 320 to 500 fine grit emery cloth for polishing. All pistons should move freely without binding or catching; excessive clearance between mating parts, however, will result in excessive leakage of pressure oil within the governor.

2. Be extremely careful when polishing pilot valve (49, figure 8-28) control land. Leave the corners sharp; broken or rounded corners on this land will ruin the pilot valve.

3. If ground bottom surface of the case (69) is grooved or worn from rotation of the pump gears (58 and 59), or scratched from mishandling, it may be surface ground. Up to 1/32 inch may be removed. Lap the surface smooth on a flat plate if a surface grinder is not available.

CAUTION

Do not remove more stock than necessary to clean up.

4. If the ground, flat surface of the base (62) is warped, nicked, or deeply scratched, it may be lapped smooth on a flat plate. If the depth of the gear pockets is reduced, the gears will bind; in this event, the faces of the gears (58 and 59) must be lapped to provide clearance.

b. Governor drive housing.

1. Repair gear (28 and 29, figure 8-29) teeth that have small nicks with a fine hone.

### 8-131. REASSEMBLY.

a. Utility governor. Refer to figure 8-28 and reassemble utility governor assembly in the reverse order of index number [illegible] Pay particular attention to the follow

1. Drive dowel pins (60) out of base (62).

2. If necessary to install new bushings (67 and 68), insert a suitable support plate of exactly the correct width between the inner walls of the case (69). Press bushings (67 and 68) in with arbor press to dimensions shown in figure 8-30. Press in idler gear stud (66) to depth shown in figure 8-30.

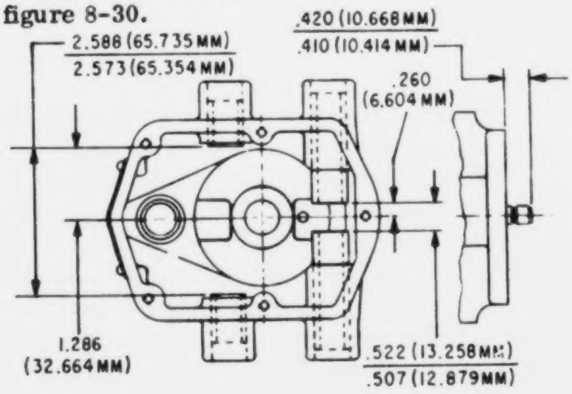


Figure 8-30. Dimensions for installing utility governor assembly bushings

3. After installing bushings (67 and 68, figure 8-33), line size or line ream with standard 3/8 inch (9.525 mm) diameter line reamer.

4. Place pump gears (58 and 59) in gear pockets of base (62).

CAUTION

Do not use adhesive on surface of base (62).

5. Coat surface of base (62) with engine oil (precise generator sets only).

6. Place gasket (61) in groove of base (62).

7. Place case (69) on base (62), invert, and put the bushing assembly (54) in through the bottom of the base (62) to permit rotating the pump gears (58 and 59).

8. Insert base screws (42) and tighten while turning bushing assembly (54) to insure free rotation of gears (58 and 59).

9. Insert dowel pins (60) and drive them down approximately 1/16 inch (1.587 mm) below base (62) surface. Remove bushing assembly (54).

10. Place the ballhead assembly (57) and bushing assembly (54) into its correct position in the case (69), and using suitable snap ring pliers install the snap ring (43).

11. Turn bushing assembly with fingers. If it binds, loosen screws (42) slightly and free up by striking at corners of base (62). Tighten screws (42) and recheck.

12. Assemble seat (48) to pilot valve (49), secure with nut (47), and wind

the spring (46) and fork (45) firmly into the spring seat. Each end of spring (46) must be securely attached to its mating part.

13. Be sure relief valve plunger (33) moves freely in sleeve assembly (34) (plunger installed with small diameter towards outside of governor). Sleeve must fit freely into case (69) bore.

14. Install high speed stop screw (19) to the distance noted during disassembly paragraph 8-127, step a.3.

b. Governor drive housing. Refer to figure 8-29 and reassemble governor drive housing in the reverse order of index numbers assigned. Pay particular attention to the following:

1. Press bushing (33) into plate (34) with open end of bushing flush with housing side of plate.

2. Position pin assembly (15) in housing by compressing spring with disc and using plug (14) hole.

3. Install shaft (13) in housing with bearing (11) and seal (12).

4. Install key (10) on shaft (13).

NOTE

Insert a suitable spacer between lever (9) and housing (31) when installing lever to prevent damage to pin assembly (15).

NOTE

If screw (6, figure 8-29) was removed, fuel injection pump must be readjusted (refer to paragraph 8-140).

## 8-132. INSTALLATION.

a. Governor drive housing. Refer to figure 8-27 and install governor drive housing in reverse order of index numbers assigned. Pay particular attention to the following:

1. Install plate (19) to rear of fuel injection pump. Plate (19) is located with two dowels secured in pump housing.

2. Position pin assembly (16) so that slot is engaged with fuel injector pump shaft (refer to figure 8-31).

3. Compress spring (10, figure 8-27) and install cover assembly (9).

4. Actuate shaft (13, figure 8-29) and note that the fuel rack and each extension move together (refer to figure 8-32).

5. Check operation of fuel shutdown lever. Fuel rack should move to the no fuel position when lever is actuated.

b. Utility governor adjustment-off unit. Set utility governor droop setting prior to installation on the engine. Refer to figure 8-33 and set droop adjust bracket (11, figure 8-28) 0.187 inch (4.749 mm) from edge of lever (18) when viewed in the position shown.

NOTE

This setting is nominal. Additional adjustment may have to be made. Refer to paragraph 8-237 for final adjustments during engine operation.

c. Utility governor and linkage. Refer to figure 8-26 and install utility governor linkage and oil lines in the reverse order of index numbers assigned. Pay particular attention to the following:

1. Install spring (40) with bolt (38) and washers (39).

2. Install fitting (37) and tube (22).

3. Install new gaskets (35) and mounting plate (36).

4. Install utility governor assembly (30) on the four mounting studs of the governor drive housing. Governor drive coupling will engage spline on utility governor drive shaft. Do not force. If coupling and spline do not engage, pull utility governor back just far enough to rotate utility governor drive shaft with the fingers, into a new position.

5. Connect spring (40) to lever (34) with bolt (17), washers, (18) and nut (15).

6. Install oil lines in such a manner that undue stress is not applied to the tube assemblies when positioning the fittings.

7. Install governor linkage in accordance with figure 8-26. Adjust rod assembly (4, 5 and 6) in accordance with operator and organizational maintenance manual. Whenever precise governor linkage is to be installed, refer to operator and organizational maintenance manual.

d. Install hydraulic tank (precise sets only) (refer to paragraph 8-92).

e. Install governor actuator unit (precise sets only (paragraph 8-116).

f. Refer to operator and organizational maintenance manual for the following:

1. Install manual speed control.
2. Make final adjustment.

NOTE

For units equipped with an engine shutdown assembly, see the organizational and maintenance manual for adjustment and operational test.

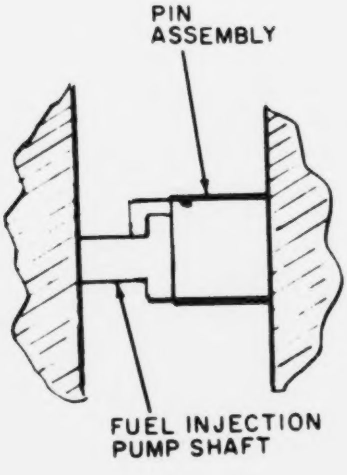
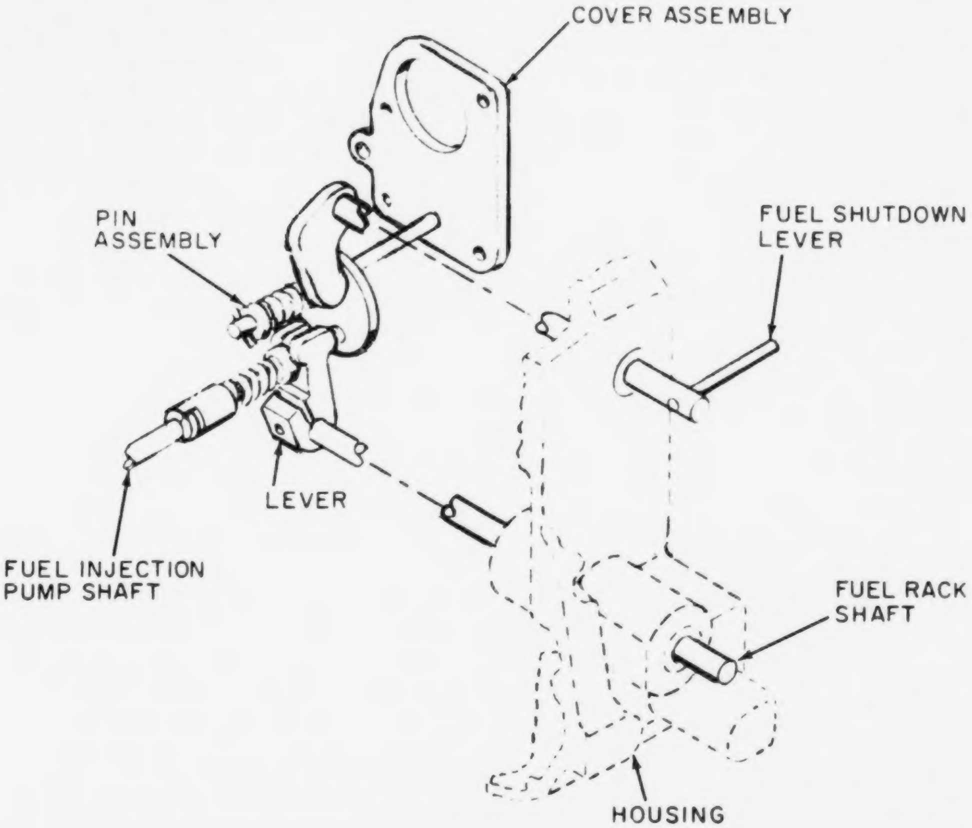


Figure 8-31. Engagement of pin assembly.to fuel injection pump shaft


COVER ASSEMBLY
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FUEL INJECTION PUMP SHAFT
FUEL RACK SHAFT
HOUSING

Figure 8-32. Fuel rack operation

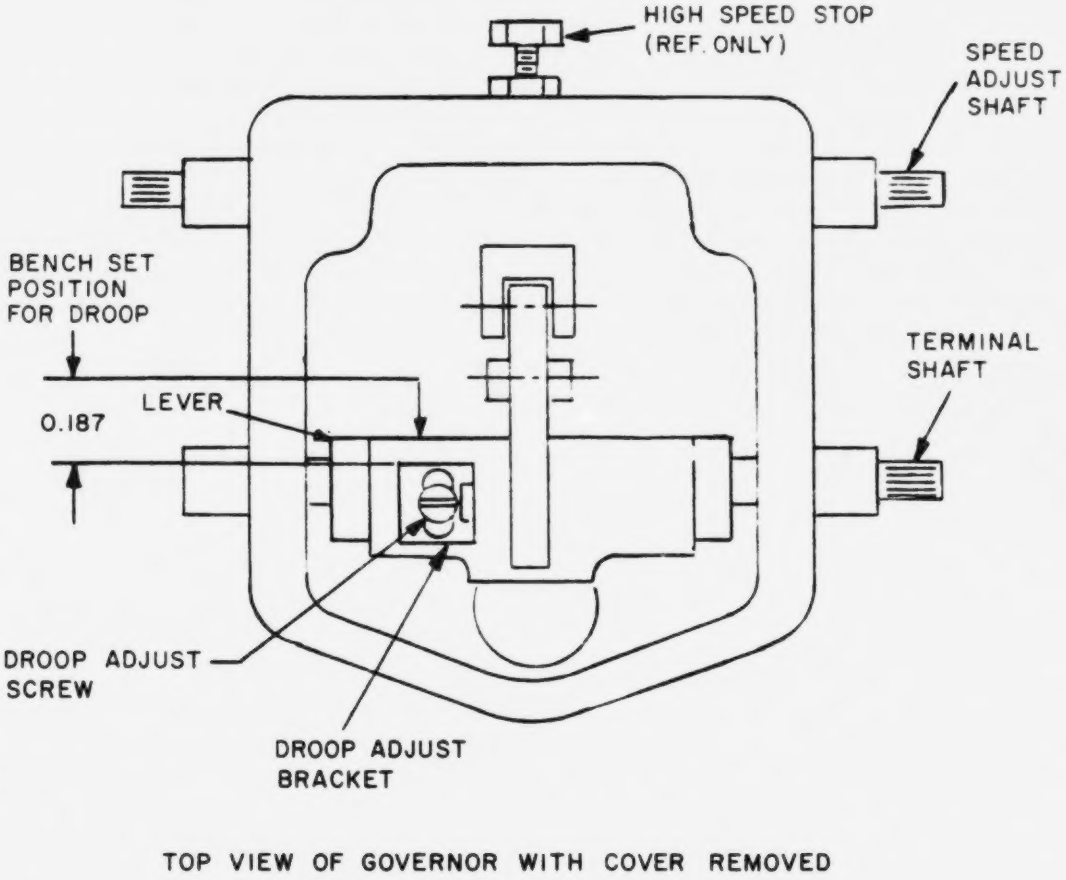
HIGH SPEED STOP
(REF. ONLY)
SPEED ADJUST SHAFT
BENCH SET POSITION FOR DROOP
TERMINAL SHAFT
LEVER
0.187
DROOP ADJUST SCREW
DROOP ADJUST BRACKET
TOP VIEW OF GOVERNOR WITH COVER REMOVED

Figure 8-33. Utility governor droop setting

## Section XVIII. FUEL INJECTION GROUP

### 8-133. GENERAL.

The fuel injection group is mounted to the rear of the accessory drive housing. The fuel injection group consists of the fuel injection pump housing, cam shaft, fuel injection pumps, fuel injection valves, and associated tubing. Fuel, after passing through the filters, flows into the injection pump housing manifold which distributes the fuel to the injection pumps. The injection pump for each cylinder measures and delivers the fuel to its associated fuel injection valve for insertion into the precombustion chamber. The amount of fuel pumped per stroke is varied by turning the pump plunger in the barrel. This turning is accomplished by governor action through the fuel regulator rack and gear arrangement. Injection pump plungers and lifters are lifted by lobes on the fuel injection cam shaft.

### 8-134. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual and remove oil filter group.

b. Refer to Operator and Organizational Maintenance Manual and remove hydraulic oil filter (precise generator sets only).

c. Remove utility governor group (paragraph 8-126).

d. Remove top engine cover plate, hardware and gasket. Refer to Operator and Organizational Maintenance Manual.

NOTE

Removal of the forward unit house roof section will simplify the removal and reinstallation of the injector valve assemblies (25, figure 8-34) and line assemblies (18). Refer to Operator and Organizational Maintenance Manual.

### 8-135. DISASSEMBLY.

Refer to figure 8-34 and disassemble fuel injection group in the order of index numbers assigned. Pay particular attention to the following:

CAUTION

Install suitable protective cap over thread on adapter (24) to protect thread after removal of injector line (18).

a. As each injector valve assembly (25) is removed it must be tagged with the number of the cylinder that it was removed from.

b. Prior to disassembly of valve assemblies (25) and fuel injection pumps, perform tests outlined in paragraph 8-141, step a.

CAUTION

All service work should be done at a cleaning facility. Hands should be clean and disassembly done on a clean, lint free cloth. Keep parts for each injection pump separate, since each pump has matched parts that are not interchangeable.

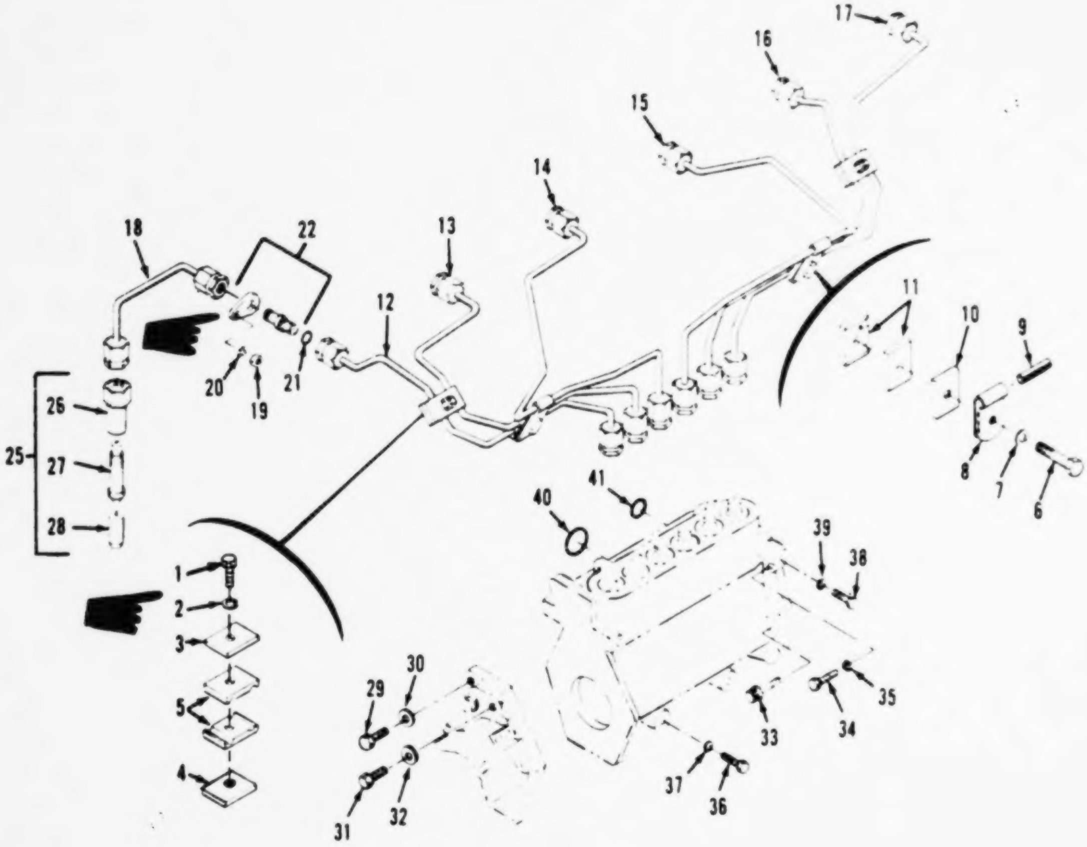
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Figure 8-34. Fuel Injection Group, Exploded View (Sheet 1 of 2)

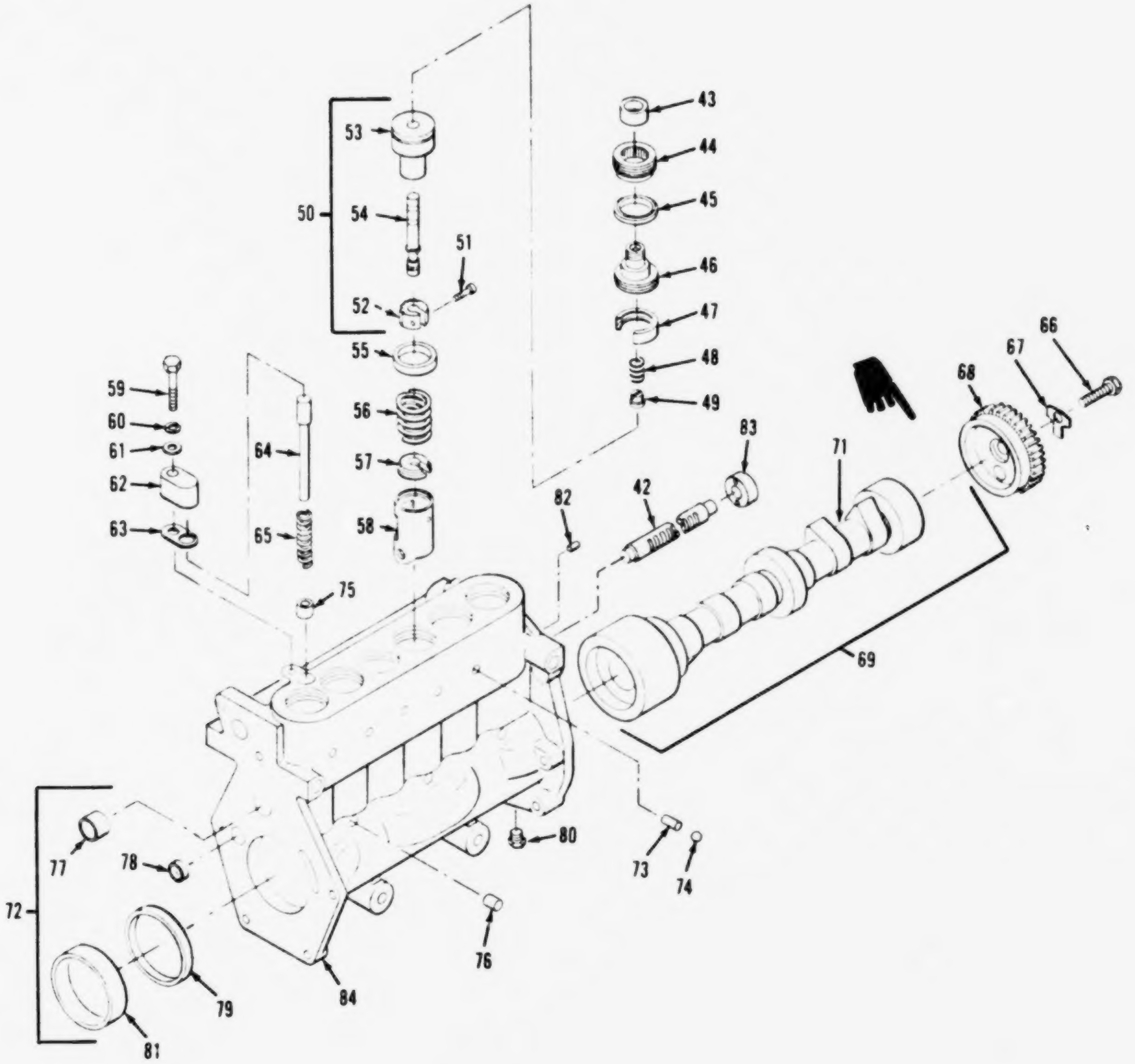
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Figure 8-34. Fuel injection group, exploded view (sheet 2 of 2)

Legend to figure 8-34:

1. Screw (2)
2. Lock washer (2)
3. Washer (2)
4. Strip (2)
5. Damper (4)
6. Bolt (2)
7. Lock washer (2)
8. Clip (2)
9. Grommet (2)
10. Strip (2)
11. Damper (4)
12. Line assembly
13. Line assembly
14. Line assembly
15. Line assembly
16. Line assembly
17. Line assembly
18. Line assembly (6)
19. Nut (6)
20. Lock washer (6)
21. Seal (6)
22. Adapter assembly (6)
23. Lock
24. Adapter
25. Valve assembly (6)
26. Nut
27. Body
28. Nozzle assembly
29. Bolt (5)
30. Lock washer (5)
31. Bolt
32. Lock washer
33. Bolt
34. Bolt
35. Lock washer
36. Bolt (3)
37. Lock washer (3)
38. Bolt
39. Lock washer
40. Seal
41. Seal
42. Fuel rack
43. Felt washer (6)
44. Bushing (6)
45. Seal (6)
46. Bonnet (6)
47. Ring (6)
48. Spring (6)
49. Check (6)
50. Plunger and barrel assembly (6)
51. Screw
52. Gear
53. Barrel
54. Plunger
55. Spacer (6)
56. Spring (6)
57. Washer (6)
58. Lifter assembly (6)
59. Bolt
60. Lock washer
61. Washer
62. Cover
63. Gasket
64. Pin
65. Spring
66. Bolt
67. Lock
68. Gear
69. Camshaft assembly
70. Deleted
71. Camshaft
72. Housing assembly
73. Pin (6)
74. Ball (6)
75. Bushing
76. Pin (3)
77. Bearing
78. Plug
79. Bearing
80. Plug
81. Bearing
82. Pin
83. Bearing
84. Housing

c. Using a suitable extracting tool, remove fuel pump items (43 through 58).

d. Fuel regulator rack (42) must be removed before removing lifters (58).

e. Using a suitable driver, remove bearing (79).

f. Using a suitable removal tool, remove camshaft bearing (81).

g. When removing fuel regulator rack bearings (77 and 83), first make two scribe marks on housing above groove on bearing (figure 8-35). This procedure allows for the alignment of groove on bearing with drilled lubrication passage during reassembly.

h. Wire together each spacer (55) figure 8-34 and fuel pump lifter (58). Tag each pair and identify the pump bore from which they were removed.

## 8-136. CLEANING.

Clean metal components with an approved cleaning solvent to remove fuel oil and accumulated deposits, and flush thoroughly.

### CAUTION

Do not attempt to clean injector nozzle (28) orifice opening.

## 8-137. INSPECTION.

a. Refer to table 1-1, and using a suitable micrometer and feeler gauge, check for excessive wear as follows:

1. Rack bearing bore
2. Fuel rack diameter

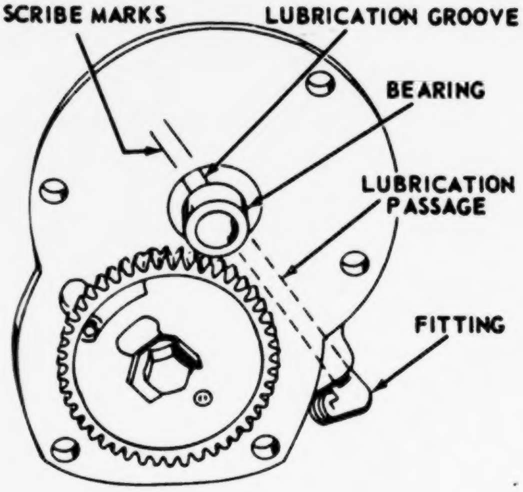


Figure 8-35. Removing fuel regulator rack bearings

3. Fuel rack to bearing clearance
4. Camshaft bearing bore
5. Camshaft bearing journal diameter
6. Camshaft to bearing clearance
7. Pump plunger length. Inspect plungers (54), figure 8-34) for excessive wear on end which makes contact with lifting washers (57). Length of new plunger is 2.5031 to 2.5937 inches (65.864 to 65.879 mm) . The minimum allowable length that a worn plunger may continue to be used is 2.5881 inches (65.737 mm).

### NOTE

Whenever a plunger is replaced, it is necessary to replace the entire pump assembly.

8. If allowable limits are not met on above parts, replace part.

b. Inspect pump housing (84) for cracks, breaks, and clogged oil passages.

c. Inspect the drive tang on camshaft (71) and bearing (81) for signs of wear.

d. Inspect camshaft (71) for damaged lobes.

e. Inspect plunger and barrel assembly (50), lifter assembly (58), and washer (57) for excessive wear or damage.

f. Inspect fuel rack (42) for nicks and burrs and for chipped or cracked gear teeth. If gear segments are cracked or chipped, replace fuel rack.

g. Inspect injector nozzle body (28) for nicks and burrs.

h. Inspect female threads on injector line (18) nut for signs of excessive torque or cross threading. Inspect ferrule at each end for ridges or signs of distortion.

i. Inspect male threads on injector body nut (26) and bulkhead adapter (24) for signs of excessive torque or cross threading.

j. Inspect threaded connection between the injector nozzle (28) and the injector body (27) for signs of excessive torque which would be indicated by deformation of the mating surface on top of the injector nozzle (28).

## 8-138. REPAIR.

a. Repair minor nicks and burrs on rack (42, figure 8-34) using a suitable hone.

b. Ream out clogged passages in housing (84) with a thin flexible wire. After cleaning passages, flush with fuel oil.

c. Repair minor thread damage using suitable thread chaser.

d. Repair of damage to injector line (18) nuts or ferrules or damage to any threaded connection on injector nozzle (28), injector body (27) and injector body nut (26) is by replacement only.

## 8-139. REASSEMBLY.

Refer to figure 8-34 and reassemble fuel injection group in the reverse order of index numbers assigned. Pay particular attention to the following:

### CAUTION

All assembly should be done with clean hands and on a clean, lint free cloth.

a. Using a suitable installing tool, install fuel regulator rack bearing (77) so that hole in bearing aligns with passage in housing (84).

b. Install fuel regulator rack bearing (83) so that groove in bearing aligns with scribe marks on housing (84).

c. Use a suitable fuel rack setting gauge when installing fuel regulator rack, figure 8-36. Position fuel regulator rack so that gauge indicates 0.000 inch (0 mm).

### CAUTION

A misaligned fuel injection pump can cause an engine to overspeed with resultant damage to engine and turbocharger.

d. Install each fuel injection pump so that notches engage with locating dowel

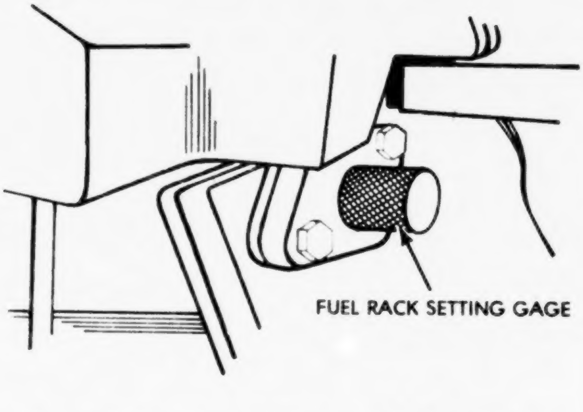


Figure 8-36. Installing fuel regulator rack

pin (73) in each housing bore. Use a suitable installing tool.

CAUTION

When tightening bushing (44), a lesser torque value will allow pump to leak; a greater torque value can damage housing.

e. Tighten each pump bushing (44) to a torque value of 140 to 160 foot pounds (19.362 to 22.128 KG-meters).

f. After pumps are installed, adjust fuel regulator rack setting. With fuel regulator rack at extreme fuel on position, rack setting guage should indicate approximately ± .325 (8.255 mm) inch minimum. If reading is less than ± .325 (8.255 mm) inch, remove pump assemblies, position fuel regulator rack to 0.000 inch (0 mm), and reinstall pumps. Recheck extreme fuel on rack position.

g. Thread injector body (27) into nozzle (28). Continue to engage thread until top of nozzle (28) makes contact with flange on injector body (27). Tighten only finger tight. Do not use tools of any kind to tighten. Do not mar surface of nozzle body diameter.

h. Install nozzle (28) and injector body (27) assembly into precombustion chamber. Rotate top of injector body (27) in a clockwise direction until serrations on injector body (27) mate with serrations in precombustion chamber and entire assembly drops into position.

i. Place injector body nut (26) over the injector body (27) and allow it to drop down until threads engage. Tighten injector body nut to a torque of 105 ± 5 foot pounds (14.522 ± .6915 kg - meters).

CAUTION

Do not over torque

j. Install injector line assembly (18) to top of injector assembly (25) and bulkhead adapter (24). Install both nuts only finger tight until it is known that crossthreading has not taken place. Torque injector line assembly nuts to 30 ± 5 foot pounds (4.149 ± .6915 kg - meters) using suitable adapter.

NOTE

Injector line assemblies (18) are not matched to any particular cylinder or adapter.

## 8-140. INSTALLATION.

NOTE

Perform fuel injection pump timing dimension check and adjustment specified in paragraph 8-141, step b.

a. Installation of fuel injection group is accomplished during reassembly (paragraph 8-139).

b. Install top engine cover. Refer to Operator and Organizational Maintenance Manual.

c. Install utility governor group (paragraph 8-132).

d. Refer to Operator and Organizational Maintenance Manual and install hydraulic oil filter (precise generator sets only).

e. Refer to Operator and Organizational Maintenance Manual and install oil filter group.

f. Refer to Operator and Organizational Maintenance Manual and install the forward unit house roof if removed.

## 8-141. TESTING.

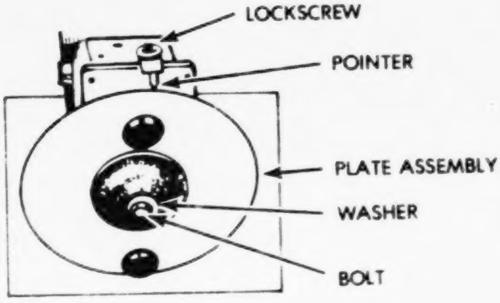
a. TEST FUEL INJECTION VALVES FOR SPRAY CHARACTERISTICS, VALVE OPENING PRESSURE AND LEAKING RATE. Using a suitable diesel injector pump test stand and a suitable diesel injector tool test set, perform the following:

1. Before testing valve assembly (25, figure 8-34), inspect screen filter. If screen is broken or clogged, discard valve assembly (25).

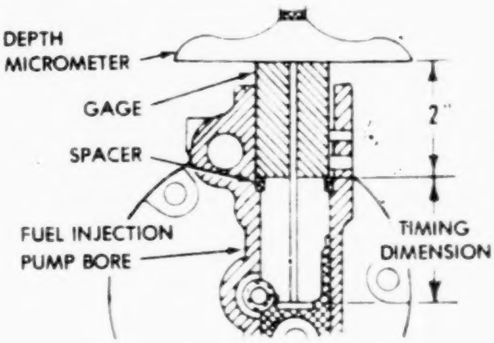
2. Apply 1875 psi (131.812 kg/cm$^2$) to valve assembly (25). A satisfactory valve should emit a complete atomized spray with a sharp cut-off of fuel and no air dribble. If valve assembly (25) emits a solid stream of fuel with little or no atomization, replace nozzle assembly (28).

3. Nozzle assembly (28) unseating pressure should be between 400 and 800 psi (28.122 and 56.245 kg/cm$^2$). If valve assembly fails to reach a minimum of 400 psi, replace nozzle assembly (28). Reduce gauge pressure to 300 psi (21.0921 kg/cm$^2$). Observe the gauge and note whether leakage causes an additional drop in pressure. If pressure falls more than 100 psi (7.0307 kg/cm$^2$) in 30 seconds, replace the nozzle assembly (28).

b. FUEL INJECTION PUMP TIMING DIMENSION CHECK AND ADJUSTMENT-OFF ENGINE (See figure 8-37).



TIMING DIMENSION SETTING (OFF ENGINE)



CHECKING TIMING DIMENSION SETTING

Figure 8-37. Fuel injection timing - off the engine

1. Install a suitable pointer assembly on fuel injection pump housing.

2. Install a suitable timing plate on drive end of fuel injection camshaft (71, figure 8-34).

3. Remove fuel injection pump for cylinder being checked (paragraphs 8-134 and 8-135). Install gauge in pump bore.

4. Refer to Table 8-1 and select the timing plate degree setting for lifter being checked. Rotate timing plate counterclockwise until proper degree setting aligns with pointer assembly (figure 8-37). Tighten screw to lock in position.

Table 8-1. Timing Plate Degree Settings

| Lifter number (numbered consecutively front to rear) | Timing Plate Degrees |
|---|---|
| 1 | 211° 30' (3.68 radian .0087') |
| 2 | 331° 30' (5.77 radian .0087') |
| 3 | 91° 30' (1.58 radian .0087') |
| 4 | 271° 30' (4.73 radian .0087') |
| 5 | 151° 30' (2.64 radian .0087') |
| 6 | 31° 30' (.541 radian .0087') |

5. Measure timing dimension using a depth micrometer. Timing dimension should be 4.390 to 4.394 inches (111.506 to 111.607 mm). If timing dimension is correct, proceed to step 7. If timing dimension is not correct, proceed to step 6.

6. If timing dimension is not correct, replace washer (55, figure 8-34). Select a washer thickness which will correct the timing dimension. Washers (57) are available in varying thicknesses from 0.170 to 0.198 inch (4.318 to 5.029 mm). Recheck timing dimension.

7. Install fuel injection pump as outlined in paragraph 8-140.

8. If timing dimension is to be checked for each cylinder, repeat steps 7. through 8. following firing order of engine.

C. FUEL INJECTION PUMP TIMING DIMENSION CHECK AND ADJUSTMENT ON UNIT. Using a suitable timing test set, perform the following:

1. Install timing indicator in cylinder and disconnect fuel line from corresponding fuel injection pump and move fuel rack to full load position.

2. Apply air pressure of 10 to 15 PSI (.07031 to 1.0546 kg/sq cm) to fuel day tank.

CAUTION

Air pressure in fuel day tanks exceeding 15 PSI (1.0546 kg/sq cm) can damage tank. If shop air is used, a suitable valve must be used to regulate air pressure to less than 15 PSI (1.0546 kg/sq cm).

3. Rotate crankshaft very slowly in normal direction until fuel flow is reduced to approximately 6 drops per minute (point of closing inlet port) from injection pump.

4. Zero indicator

5. Release the air pressure in system.

6. Continue to rotate crankshaft until indicator reads maximum value (piston at top center). Indicator reading should be 0.0916 in ± 10% (2.327 ± .232 mm) (11° (.1919 radian) timing angle).

## Section XIX. ACCESSORY DRIVE GROUP

### 8-142. GENERAL.

The accessory drive group is mounted to the timing gear housing plate. The accessory drive group consists of housing assembly, gear assembly, drive shaft, bearing, sleeve, and idler gear. The accessory drive shaft drives the utility governor and fuel injection pump.

### 8-143. REMOVAL.

a. Prior to removal of the accessory drive group, remove the following:

1. Remove overspeed governor (paragraph 8-54).

2. Remove fuel pump group (paragraph 8-62).

3. Refer to Operator and Organizational Manual and remove secondary fuel filter body.

4. Remove utility governor group (paragraph 8-126).

5. Remove fuel injection group (paragraph 8-134).

b. Removal of the accessory drive group is accomplished during disassembly.

### 8-144. DISASSEMBLY.

Refer to figure 8-38 and disassemble accessory drive group in the order of index numbers assigned.

### 8-145. CLEANING.

a. Wash all parts in approved solvent and dry with low pressure compressed air or a lint-free cloth. Do not spin dry bearings.

### 8-146. INSPECTION.

a. Refer to table 1-1 and inspect parts for dimensional tolerances.

b. Check bearings for freedom of rotation, replace a bearing if its rotation is rough.

c. Inspect bearings for pits, scratches, cracks, or chipped race.

d. Inspect bearings and mating surfaces for grooves and discoloration.

e. Inspect housing for cracks. Replace cracked housing.

f. Inspect gear teeth for nicks, burrs, cracks, and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of the gear.

g. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

h. Inspect threaded parts for thread damage.

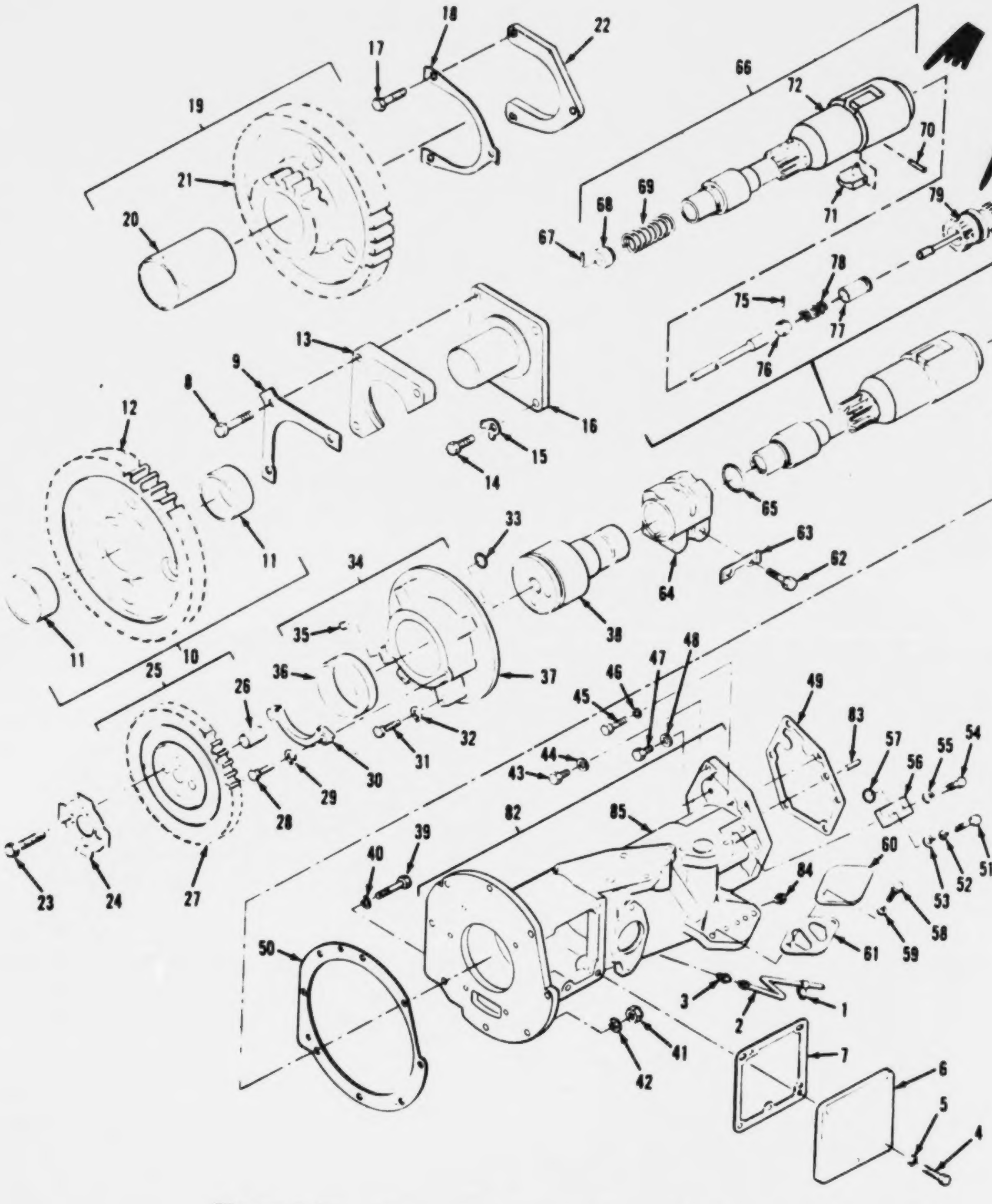

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Figure 8-38. Accessory drive group, exploded view

Legend to figure 8-38:

1. Clip
2. Tube
3. Fitting
4. Bolt (5)
5. Lock washer (5)
6. Cover
7. Gasket
8. Bolt (3)
9. Lock
10. Idler gear assembly
11. Bearing (2)
12. Gear
13. Thrust washer
14. Bolt
15. Lock
16. Shaft assembly
17. Bolt (3)
18. Lock
19. Idler gear assembly
20. Bearing
21. Gear
22. Plate
23. Bolt (4)
24. Lock
25. Gear assembly
26. Dowel
27. Gear
28. Bolt (2)
29. Lock (2)
30. Plate
31. Bolt (5)
32. Lock (5)
33. Seal (2)
34. Cage assembly
35. Plug
36. Bearing
37. Cage
38. Shaft
39. Bolt
40. Lock washer
41. Nut (7)
42. Lock washer (7)
43. Bolt (5)
44. Lock washer (5)
45. Bolt
46. Lock washer
47. Plug
48. Washer
49. Gasket
50. Gasket
51. Bolt
52. Lock washer
53. Washer
54. Pin
55. Washer
56. Cover
57. Seal
58. Bolt (2)
59. Lock washer (2)
60. Cover
61. Gasket
62. Bolt (2)
63. Lock
64. Coupling
65. Seal
66. Variable drive assembly
67. Dowel pin
68. Retainer
69. Spring
70. Dowel pin (2)
71. Weight (2)
72. Shaft assembly
73. Pin (2)
74. Rod
75. Nut
76. Valve
77. Spring
78. Piston assembly
79. Housing assembly
80. Dowel pin
81. Plug
82. Housing

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i. Discard gaskets.

8-147. REPAIR.

a. Remove minor nicks and burrs, using a suitable file or hone.

b. Repair minor thread damage using a suitable thread chaser.

8-148. REASSEMBLY.

Refer to figure 8-38 and reassemble accessory drive group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Align idler gear (19) timing mark as shown in figure 8-39

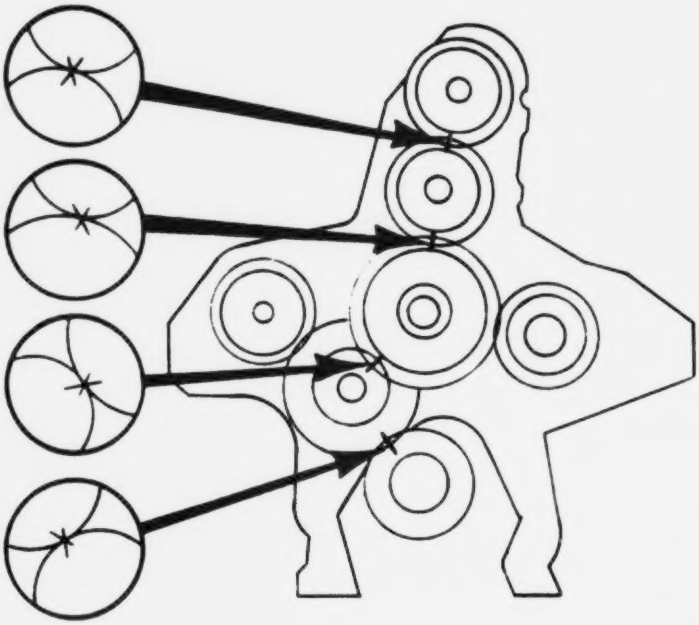

Figure 8-39. Alignment of timing marks

8-149. INSTALLATION.

a. Refer to figure 8-38 and install the accessory drive group, observing the following:

1. Torque bolts (14) from 34 to 40 foot pounds (4.702 to 5.532 kg - meters).

2. Torque bolts (23) from 66 to 74 foot pounds (9.128 to 10.234 kg - meters).

b. Install the following:

1. Install fuel injection pump group (paragraph 8-140).

2. Install utility governor group (paragraph 8-132).

3. Refer to Operator and Organizational Maintenance Manual and install secondary fuel filter tank.

4. Install fuel pump group (paragraph 8-68).

5. Install tachometer drive group (paragraph 8-60).

6. Install flywheel housing (paragraph 8-195).

7. Install turbocharger group (paragraph 8-76).

8. Install engine assembly (paragraph 2-8).

## Section XX. EXHAUST MANIFOLD GROUP

### 8-150. GENERAL.

The exhaust manifold group is mounted to the cylinder head. The exhaust manifold group consists of manifold assemblies and gaskets. The exhaust gases from the cylinders enter the exhaust manifold and are then directed to the turbocharger.

### 8-151. REMOVAL AND DISASSEMBLY.

a. Refer to Operator and Organizational Maintenance Manual and remove housing front roof.

b. Refer to figure 8-40 and remove and disassemble exhaust manifold group in the order of index numbers assigned.

### 8-152. CLEANING.

a. Remove any traces of old exhaust manifold gaskets.

b. Use an approved cleaning solvent and a stiff brush and remove all excess rust and carbon deposits from manifold and manifold hardware. Dry thoroughly. Place hardware in a container of light weight oil and allow to soak until needed for reassembly.

### 8-153. INSPECTION.

a. Inspect manifold for casting cracks around mounting flange bolt holes. Replace defective casting.

b. Inspect threaded parts for thread damage.

c. Inspect manifold mating surfaces for nicks and burrs.

d. Replace all gaskets.

e. Replace all locks and lockwashers.

### 8-154. REPAIR.

a. Remove minor nicks and burrs from manifold mating surfaces, using a suitable file or hone.

b. Repair minor thread damage using a suitable thread chaser.

### 8-155. REASSEMBLY AND INSTALLATION.

Refer to figure 8-40 and reassemble and install exhaust manifold group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Coat stud threads with an approved antiseize compound.

b. Torque manifold nuts (8) from 29 to 35 foot-pounds.

c. Refer to Operator and Organizational Maintenance Manual and install housing front roof.

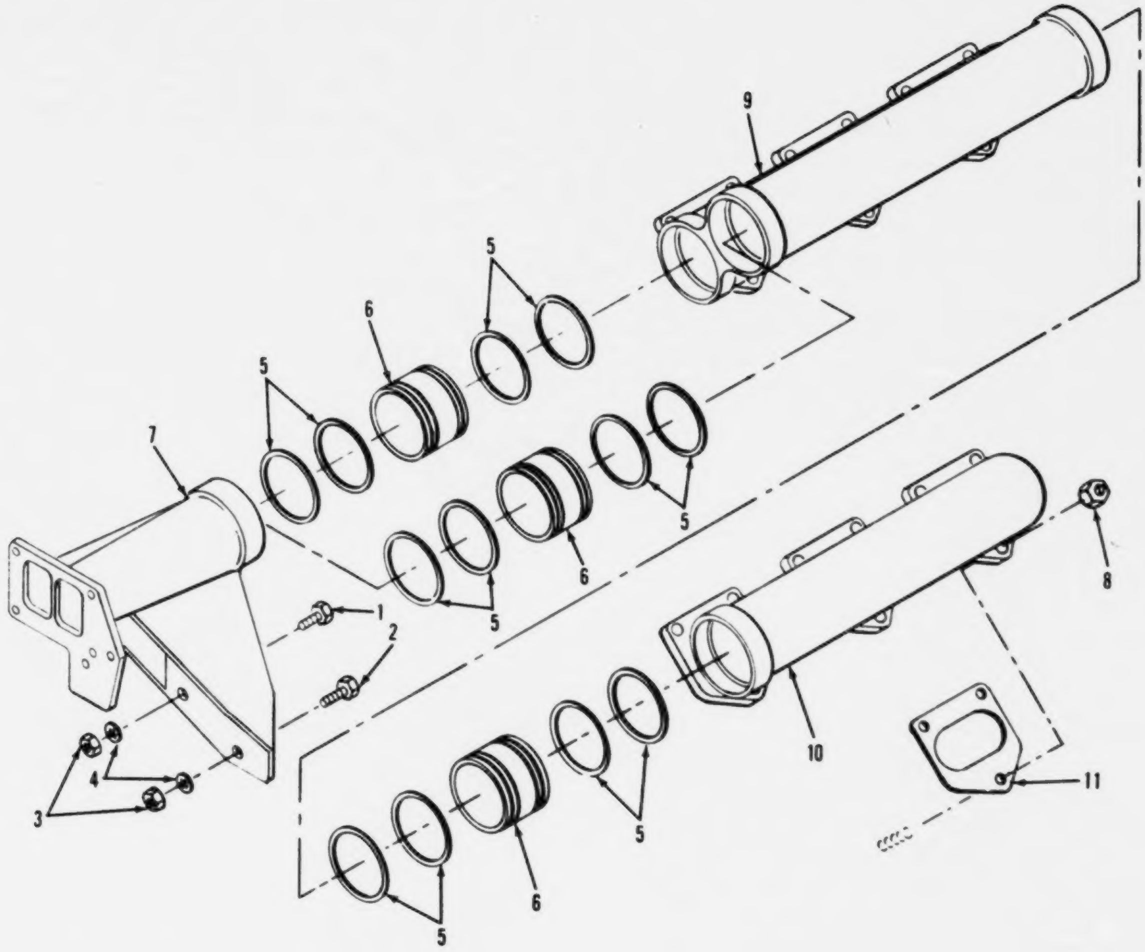

Figure 8-40. Exhaust manifold group, exploded view

Legend to figure 8-40:

1. Bolt (2)
2. Bolt (2)
3. Nut (4)
4. Lock washer (4)
5. Ring (12)
6. Sleeve (3)
7. Manifold
8. Nut (18)
9. Manifold
10. Manifold
11. Gasket (6)

## Section XXI. AFTERCOOLER GROUP

### 8-156. GENERAL.

The aftercooler group is mounted on the left side of the engine. The aftercooler consists of a tube assembly, cover, housing, and a core assembly. The waterpump directs coolant to the aftercooler. The coolant then enters the cooling system and is directed to the area around the cylinder liners and cylinder head.

### 8-157. REMOVAL.

Refer to figure 8-41, and remove aftercooler group in the order of index numbers assigned.

### 8-158. DISASSEMBLY.

Refer to figure 8-41, and disassemble aftercooler group in the order of index numbers assigned.

### 8-159. CLEANING.

a. Clean all metal parts with an approved cleaning solvent and dry thoroughly.

b. Clean calcium deposits using a stiff wire brush.

c. Remove all traces of old gasket material.

d. If tube bundle is corroded, scale deposits can be removed by reaming the tubes with a drill bit welded to end of rod long enough to penetrate length of tubes. Extreme care must be taken to avoid piercing sides of tubes with drill bit.

#### WARNING

Use extreme caution when mixing acid solution and when cleaning aftercooler. Always add acid to water when mixing; never add water to acid. Avoid any contact of solution with skin. Keep away from eyes.

e. Clean tubes with a solution of 15 percent hydrochloric acid and 85 percent water. The cooler should be immersed in or flushed with the solution until the scale is soft. Wash cooler thoroughly with water to remove scale and solution. Repeat procedure as necessary to achieve proper cleaning.

### 8-160. INSPECTION.

a. Inspect cover and housing for cracks. Replace defective parts.

b. Inspect threaded parts for thread damage.

c. Inspect gasket mating surfaces for nicks, scratches, pits, or burrs.

d. Discard seals and gaskets.

### 8-161. REPAIR.

a. Remove minor nicks and burrs using a suitable file or hone.

b. Repair minor thread damage using a suitable thread chaser.

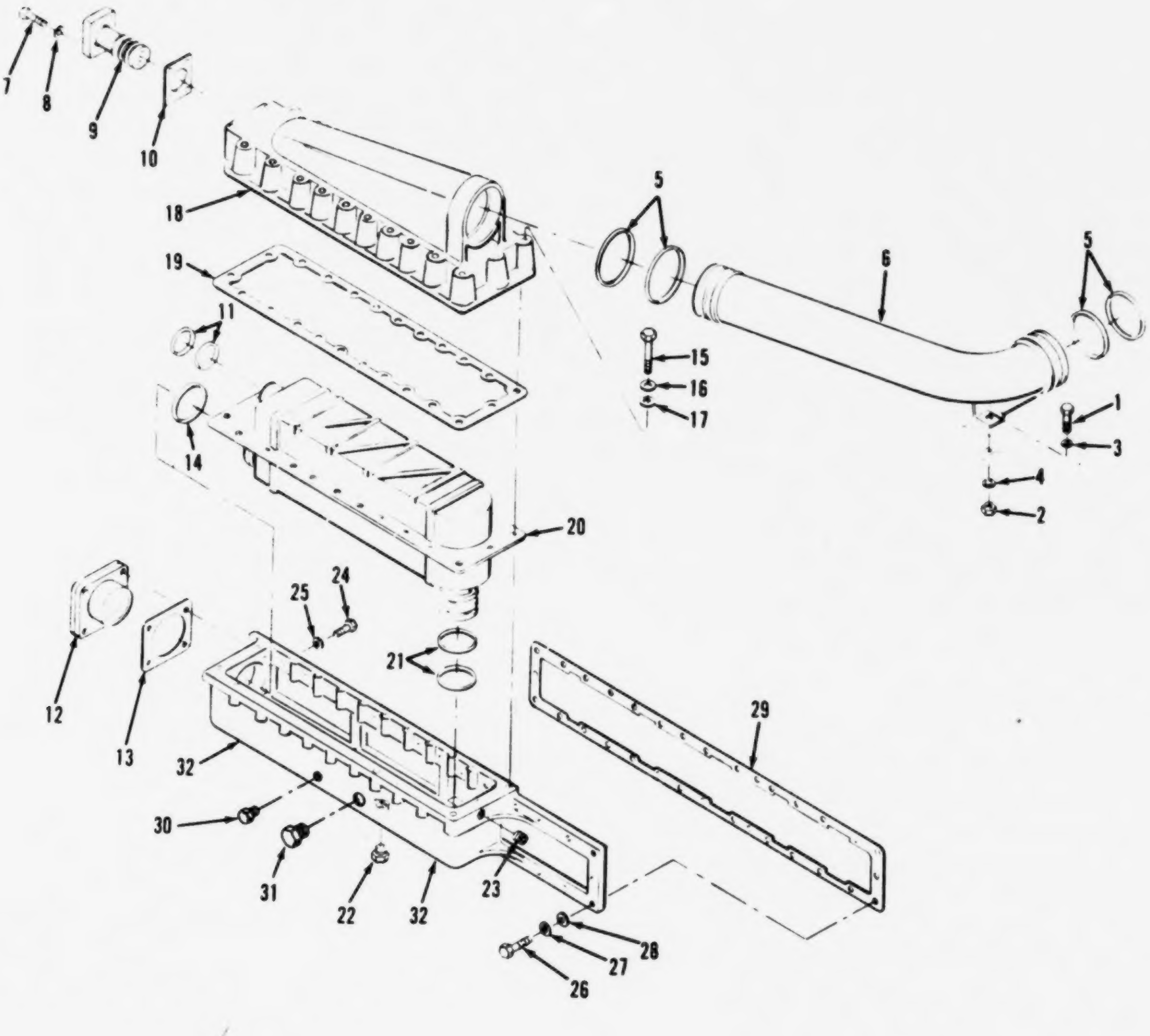
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Figure 8-41. Aftercooler group, exploded view

Legend to figure 8-41:

1. Bolt
2. Nut
3. Washer (2)
4. Lock washer
5. Seal (4)
6. Tube assembly
7. Bolt
8. Lock washer (4)
9. Cover
10. Gasket
11. Seal (2)
12. Collar
13. Gasket
14. Seal
15. Bolt (23)
16. Washer (23)
17. Washer (23)
18. Cover
19. Gasket (2)
20. Core assembly
21. Seal (2)
22. Plug
23. Plug
24. Bolt (10)
25. Lock washer (10)
26. Bolt (22)
27. Lock washer (22)
28. Washer (22)
29. Gasket
30. Plug
31. Plug
32. Housing

### 8-162. REASSEMBLY.

Refer to figure 8-41, and reassemble the aftercooler group in the reverse order of index numbers assigned.

### 8-163. INSTALLATION.

Refer to figure 8-41 and install the aftercooler group in the reverse order of index numbers assigned.

## SECTION XXII. OIL PAN GROUP AND RELATED PARTS

### 8-164. GENERAL.

The oil pan group is bolted to the bottom of the engine. The oil pan group consists of transfer tube, fluid level indicator, and drain plug. The oil sump contains an oil heater tube with external water connections. The oil pan is the reservoir which supplies the oil pump with lubricating oil.

### 8-165. REMOVAL.

a. Remove fuel tank assembly (refer to paragraph 2-7).

b. Drain oil from oil pan.

c. Disconnect oil pan drain line at valve.

d. Disconnect water connections at the rear of oil pan if unit is equipped with a heater kit.

e. Refer to figure 8-42, and remove oil pan group in the order of index numbers assigned.

### 8-166. DISASSEMBLY.

Refer to figure 8-42 and disassemble oil pan group in the order of index numbers assigned.

### 8-167. CLEANING.

a. Clean components with an approved cleaning solvent, and dry thoroughly.

b. Flush interior of oil pan with an approved cleaning solvent, and dry thoroughly. Use a stiff brush to remove encrusted oil sediment in bottom of pan.

c. Flush tube (4, figure 8-42) with an approved cleaning solvent, and dry thoroughly.

d. Flush tube (32) with an approved cleaning solvent to remove encrusted calcium deposits, and dry thoroughly.

### 8-168. INSPECTION.

a. Inspect gasket seal surface at top of oil pan for burrs, nicks, or other damage.

b. Inspect tube (32) for damage. Replace damaged tube.

c. Inspect fittings (14) for damage. Replace damaged fittings.

d. Inspect components for dents, cracks, distortion, and damaged threads.

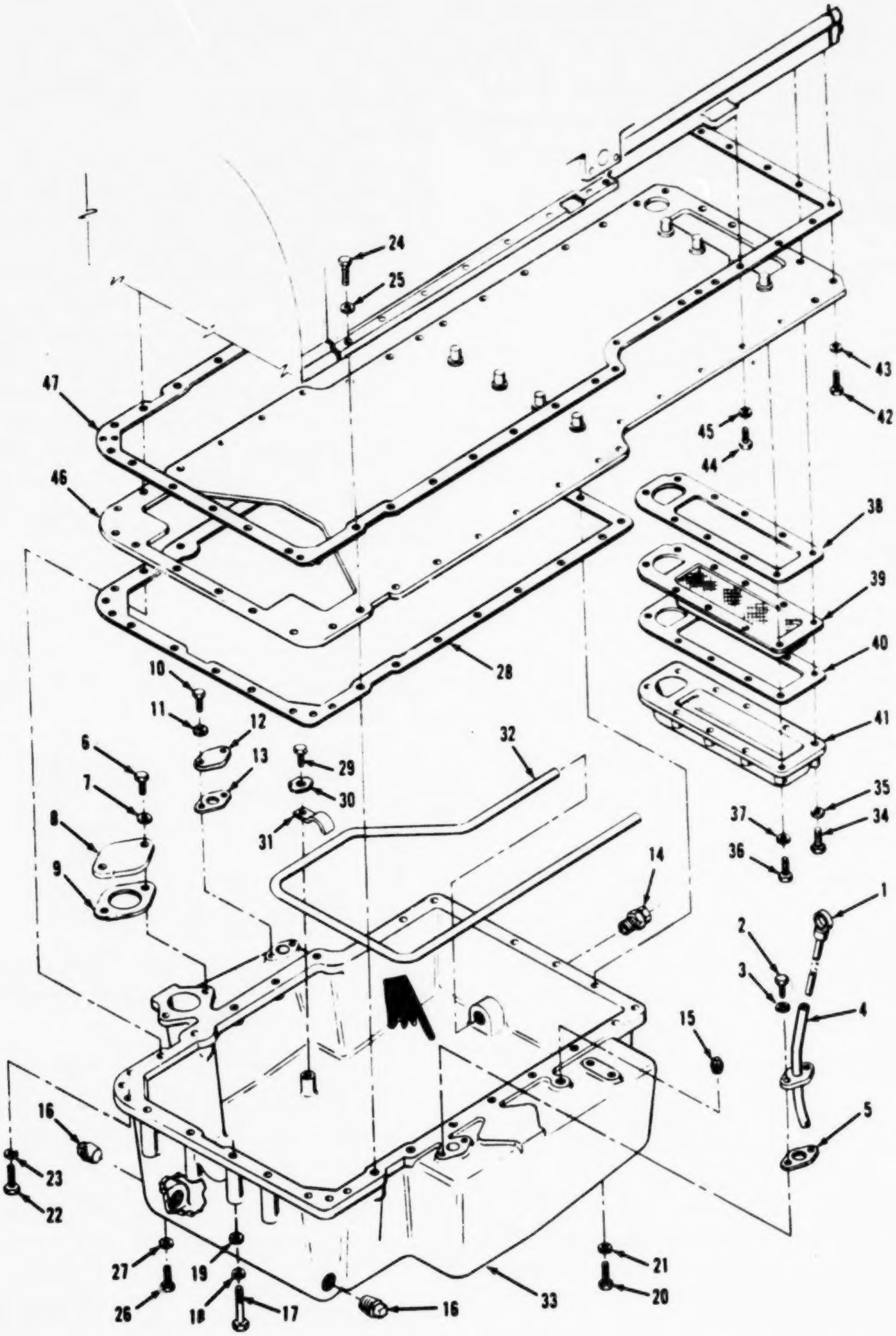
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Figure 8-42. Oil pan group and related parts, exploded view

Legend to figure 8-42:

1. Gage assembly
2. Bolt (2)
3. Lock washer (2)
4. Tube assembly
5. Gasket
6. Bolt (2)
7. Lock washer (2)
8. Cover
9. Gasket
10. Bolt (2)
11. Lock washer (2)
12. Flange
13. Gasket
*14. Fitting (2)
15. Plug
16. Plug (2)
17. Bolt (4)
18. Lock washer (4)
19. Washer (4)
20. Bolt (4)
21. Lock washer (4)
22. Bolt (10)
23. Lock washer (10)
24. Bolt (9)
25. Lock washer (9)
26. Bolt
27. Lock washer
28. Gasket
*29. Bolt (2)
*30. Lock (2)
*31. Clip (2)
*32. Tube
33. Pan
34. Bolt (6)
35. Lock washer (6)
36. Bolt (4)
37. Lock washer (4)
38. Gasket
39. Baffle assembly
40. Gasket
41. Pan
42. Bolt
43. Lock washer
44. Bolt (11)
45. Lock washer (11)
46. Plate assembly
47. Gasket

*Used on Winterization Kit only.

e. Discard gaskets (5, 9, 13, 27, 37, 39 and 46).

## 8-169. REPAIR.

a. Remove minor nicks and burrs using a suitable file or hone.

b. Repair dents and distortion using proper tools.

c. Repair minor thread damage using a suitable thread chaser.

## 8-170. REASSEMBLY.

Refer to figure 8-42, and reassemble oil pan group in the reverse order of index numbers assigned.

## 8-171. INSTALLATION.

a. Refer to figure 8-42 and install oil pan group in the reverse order of index numbers assigned.

b. Connect water connections at the rear of oil pan if unit is equipped with a heater kit.

c. Install oil pan drain line at valve.

d. Install fuel tank assembly (refer to paragraph 2-7).

## Section XXIII. OIL PUMP GROUP

### 8-172. GENERAL.

The oil pump is mounted on the bottom face of the cylinder block at the rear of the engine. The pump is a two-section, positive displacement, gear-type pump. One section scavenges oil from the rear of the engine and dumps it into the oil pan sump. The other section supplies lubrication, under pressure, to the basic engine through passages in the cylinder block, and to external components through oil lines. The pump is driven by the timing gear train.

### 8-173. REMOVAL.

a. Remove oil pan group (paragraph 8-165).

b. Refer to figure 8-43, and remove oil pump in the order of index numbers assigned.

### 8-174. DISASSEMBLY.

Refer to figure 8-43, and disassemble oil pump group in the order of index numbers assigned. Pay particular attention to the following:

a. Using a suitable puller, remove gear (19) from shaft (48).

b. Using a suitable puller, remove gears (37 and 47) from shaft (48).

c. Using a suitable arbor press, remove gear (45) from shaft (51).

d. Using a suitable arbor press, remove shaft (51) from body (52).

e. Using a suitable arbor press, remove bearing (50) from body (52) and bearings (32) from body (36).

### 8-175. CLEANING.

Clean components with an approved cleaning solvent, and dry thoroughly.

### 8-176. INSPECTION.

a. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

b. Inspect gear teeth for nicks, burrs, cracks, and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of gear.

c. Refer to table 1-1 and, using a suitable micrometer and feeler gauge, check for excessive wear as follows:

1. Drive gear shaft (48) diameter.

2. Gear to cover clearance.

3. Shaft diameters.

4. Relief valve pressure spring (25) outside diameter.

5. Using a suitable spring compressor, apply a load of 104.5 to 115.5 pounds (47.400 to 52.389 kg) and compress spring (25, figure 8-43) to a length of 4.64 inches (117.86 mm). If spring does not compress to a length of 4.64 inches (117.86 mm) under a load of 104.5 to 115.5 pounds (47.400 to 52.389 kg), replace spring. Replace spring if free length is not 6.02 inches (152.908 mm) after test.

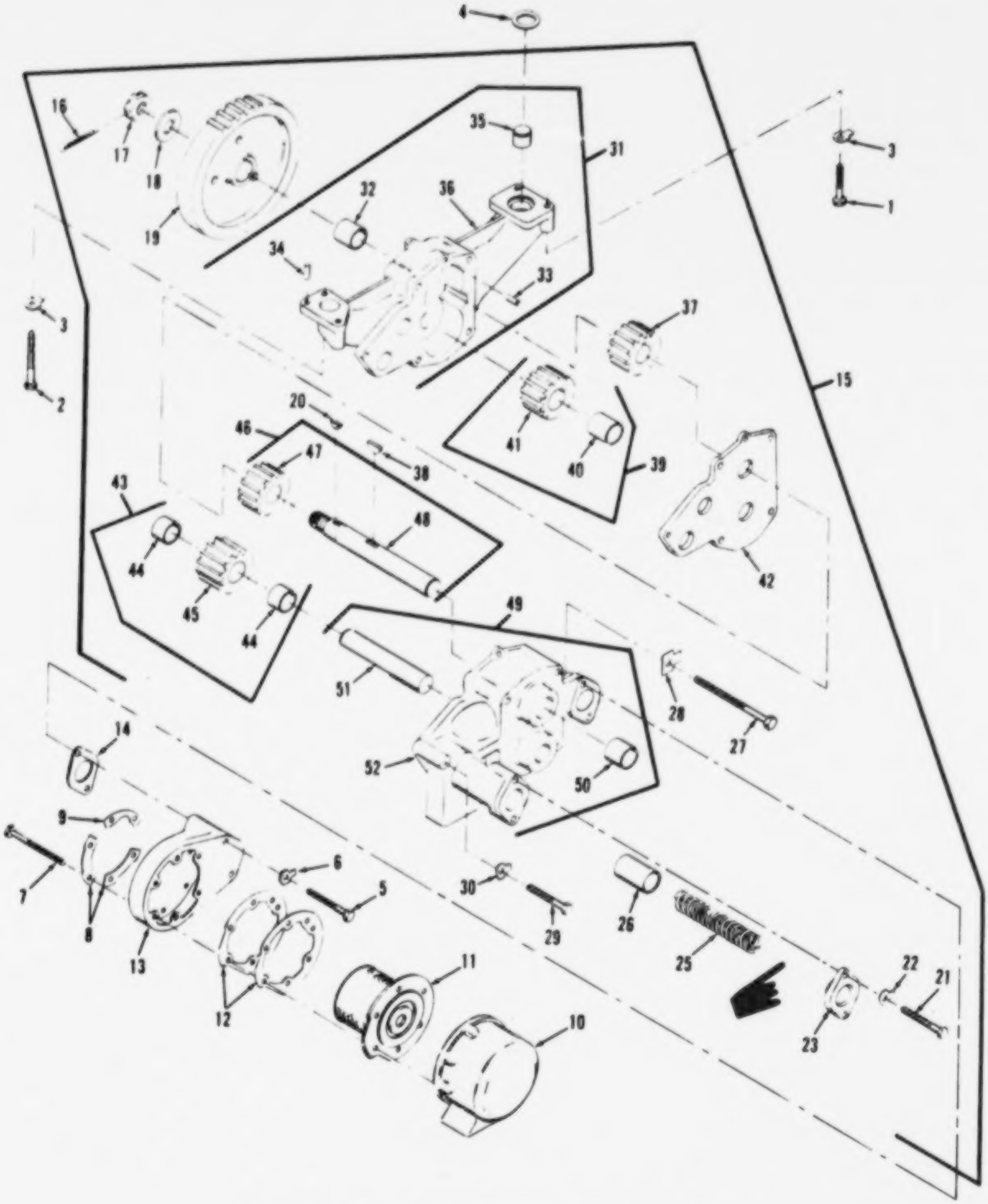
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Figure 8-43. Oil pump group, exploded view

Legend to figure 8-43:

1. Bolt (3)
2. Bolt
3. Lock (4)
4. Seal
5. Bolt (2)
6. Lock (2)
7. Bolt (6)
8. Lock (2)
9. Lock
10. Bell
11. Screen assembly
12. Gasket (2)
13. Cover
14. Gasket
15. Pump assembly
16. Cotter pin
17. Nut
18. Washer
19. Gear
20. Key
21. Bolt (2)
22. Lock (2)
23. Flange assembly
24. Not Used
25. Spring
26. Plunger
27. Bolt (4)
28. Lock (4)
29. Bolt
30. Lock
31. Body assembly
32. Bearing
33. Pin
34. Pin
35. Pin
36. Body
37. Gear
38. Key
39. Gear assembly
40. Bearing
41. Gear
42. Spacer
43. Gear assembly
44. Bushing (2)
45. Gear
46. Shaft assembly
47. Gear
48. Shaft
49. Body assembly
50. Bearing
51. Shaft
52. Body

## 8-177. REPAIR.

a. Repair minor nicks and burrs using a suitable file or hone.

b. Repair dents and distortion using proper tools.

c. Repair minor thread damage using a suitable thread chaser.

## 8-178. REASSEMBLY.

Refer to figure 8-43 and reassemble oil pump group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Using a suitable arbor press, install bearing (32) into body (36) and bearing (50) into body (52).

b. Using a suitable arbor press, install shaft (51) into body (52).

c. Using a suitable arbor press, install gear (45) onto shaft (51) and gears (37 and 47) onto shaft (48).

d. Using a suitable arbor press, install gear (19) on shaft (48). Tighten gear retaining nut (17) to 100 foot pounds (13.83 kg meters) torque, plus amount to align cotter pin (16).

e. Make sure that all shafts turn freely with no binding or drag on gears after reassembly. If gears bind, loosen pump body securing bolts, and relocate pump bodies by tapping them lightly until shafts turn freely. Retighten bolts.

## 8-179. INSTALLATION.

a. Refer to figure 8-43 and install oil pump group.

b. Refer to paragraph 8-171 and install oil pan group.

c. Refer to engine run-in (paragraph 8-237) for testing of oil pump.

## Section XXIV. CYLINDER HEAD AND VALVE MECHANISM GROUP

### 8-180. GENERAL.

The cylinder head and valve mechanism group is mounted on top of the cylinder block. The cylinder head and valve mechanism group consists of lifting eyes, base assembly, cam follower assemblies, cylinder head assembly, chamber assemblies, valve springs, valve guides, intake valves and exhaust valves. Cored passages in the cylinder head direct the flow of coolant around the valve ports and chamber assemblies. Oil passages allow lubricant to be distributed to the valve mechanism. The valve mechanisms are operated by the camshafts.

### 8-181. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual and remove housing front roof.

b. Remove turbocharger (paragraph 8-70).

c. Remove aftercooler group (paragraph 8-157).

d. Remove camshaft group (paragraph 8-197).

e. Removal of cylinder head and valve mechanism group is accomplished during disassembly (paragraph 8-182).

### 8-182. DISASSEMBLY.

Refer to figure 8-44 and disassemble cylinder head and valve mechanism group in the order of index numbers assigned. Pay particular attention to the following:

a. Install eyebolts in cylinder head. Using a suitable hoist, remove cylinder head.

b. Tag each intake and exhaust valve and the cylinder number it was taken from.

c. Using a suitable spring compressor, remove springs (52) from intake and exhaust valves (53 and 54).

NOTE

Do not remove inserts (57 and 58) unless replacement is required.

d. Using a suitable extracting tool, remove inserts (57 and 58) from cylinder head assembly (42).

### 8-183. CLEANING.

CAUTION

Do not use a wire brush or a grinding wheel when cleaning components.

a. Place valves, valve bushings, and retainers in an approved cleaning solvent and allow to soak for at least one hour. Using a stiff brush, remove all carbon lacquer and residue from parts, and dry thoroughly.

b. Remove scale from cylinder head using an approved cleaning solvent and a stiff brush, and dry thoroughly.

c. Clean metal components with an approved cleaning solvent, and dry thoroughly.

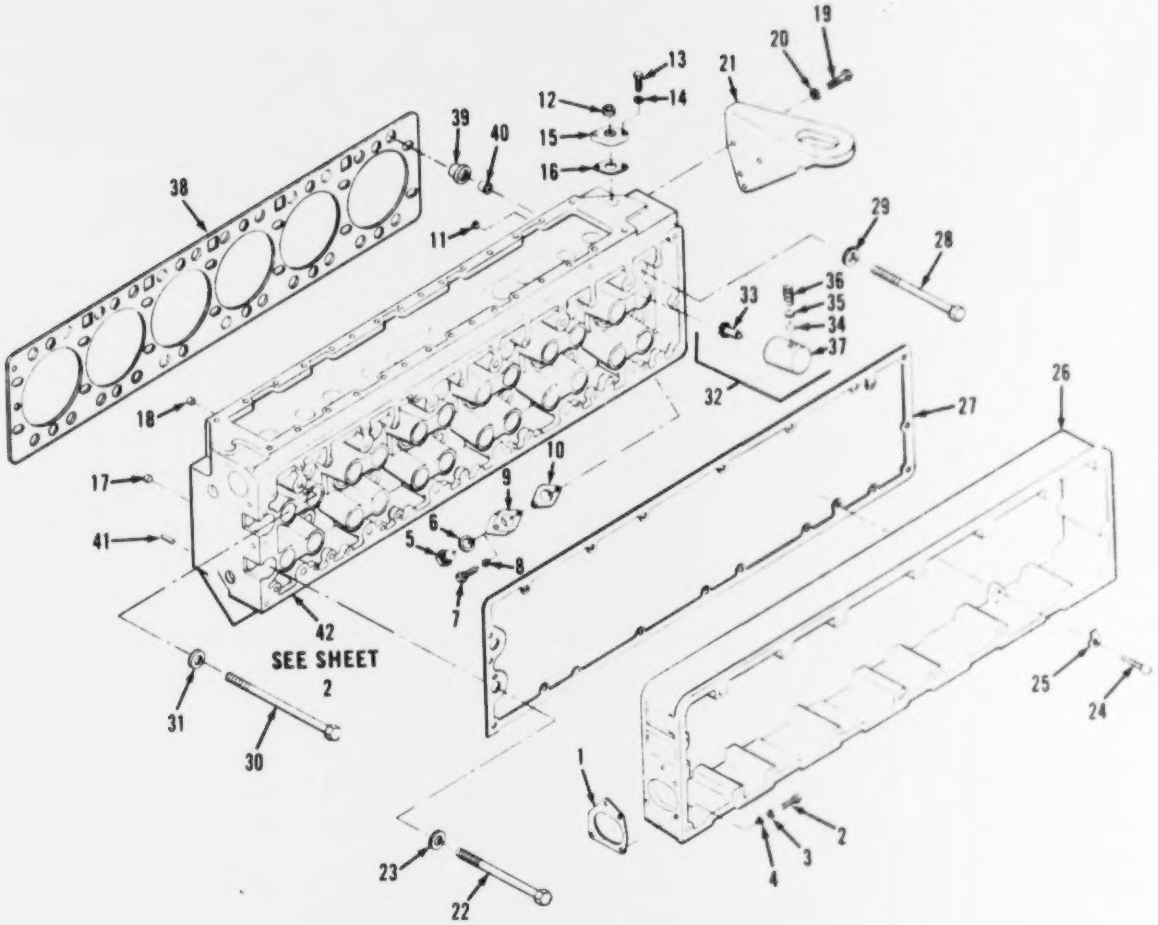
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Figure 8-44. Cylinder head group, exploded view (sheet 1 of 2)

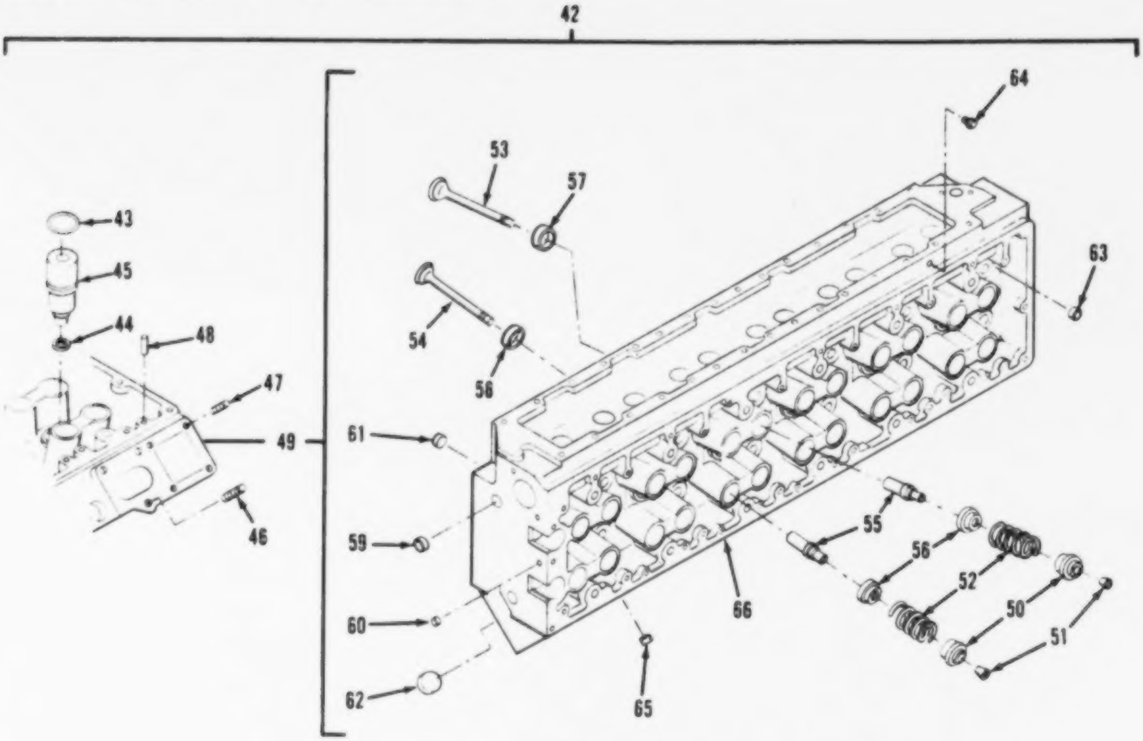


Figure 8-44. Cylinder head group, exploded view (sheet 2 of 2)

Legend to figure 8-44:

1. Gasket
2. Bolt (4)
3. Lock washer (4)
4. Washer (4)
5. Plug
6. Gasket
7. Bolt (2)
8. Lock washer (2)
9. Flange
10. Gasket
11. Plug
12. Plug
13. Bolt (2)
14. Lock washer (2)
15. Flange
16. Gasket
17. Plug
18. Seal
19. Bolt (4)
20. Lock washer (4)
21. Lifting eye
22. Bolt (2)
23. Washer (2)
24. Bolt (2)
25. Lock (2)
26. Base assembly
27. Gasket
28. Bolt (12)
29. Washer (12)
30. Bolt (12)
31. Washer (12)
32. Cam follower assembly (24)
33. Gear
34. Plug
35. Spacer
36. Spring
37. Follower
38. Gasket
39. Seal (24)
40. Ferrule (24)
41. Pin
42. Cylinder head assembly
43. Seal (6)
44. Gasket (6)
45. Chamber assembly (6)
46. Stud (18)
47. Stud (4)
48. Pin (13)
49. Head assembly
50. Retainer (24)
51. Lock (48)
52. Spring (24)
53. Inlet valve (12)
54. Exhaust valve (12)
55. Guide (24)
56. Rotocoil (24)
57. Insert (12)
58. Insert (12)
59. Plug (2)
60. Plug
61. Plug (11)
62. Plug (11)
63. Plug
64. Plug
65. Plug
66. Head

## 8-184. INSPECTION.

a. Inspect cylinder head for cracks, damaged threads, distortion or any other defect.

b. Inspect precombustion chamber assemblies (45) for damaged threads, distortion, or cracks.

c. Inspect valve springs (52, figure 8-44) for damaged coils, cracks, and distortion. Using a suitable valve spring test stand, apply a load of 51.5 to 58.5 pounds, and compress valve springs (52) to a length of 1.95 inches. Replace springs if free length after test is not 2.31 inches.

d. Inspect valve guides (55, figure 8-44) for cracks, distortion, and excessive wear. Check inside diameter of valve guides (55), using suitable pilot gauges. Refer to table 1-1 for acceptable diameter and maximum allowable wear limits. If limits are exceeded, replace valve guides.

e. Inspect valve seat inserts (57 and 58) for excessive wear, pitting, cracking or improper seat angle. The proper angle for seat and valve is 45 degrees. Refer to table 1-1, and using a suitable micrometer, check diameters of inlet valve seat inserts and exhaust valve seat inserts. If allowable limits are exceeded, replace insert.

f. Inspect valves (53 and 54) for cracks, pitting, distortion, or excessive wear. Use a suitable micrometer and check valve stem diameter. Refer to table 1-1 for maximum allowable wear limits. If limits are not met, replace valve.

g. Coat each valve (53 and 54) face with a thin film of Prussian blue, then rotate each valve in associated valve seat. Remove valves and examine contact pattern on each valve and valve seat. A line of contact near top and around entire circumference of valve seat indicates line contact with valve. This amount of line contact would indicate that the valves and valve seats are acceptable. If, however, line contact is not noted to extend completely around the seat, or gaps in line contact appear around the seat, it would indicate that the valves have to be reground.

h. Inspect valve seats (57 and 58). If valve seat does not conform to the manufacturer's minimum and maximum dimension, it can not be reground and must be replaced. Refer to figure 8-45.

i. Inspect valves (53 and 54, figure 8-44) using a suitable micrometer, and check valve head diameter, valve face angle, closed valve projection, and valve lip thickness. Refer to figure 8-45. If limits are exceeded, replace valve.

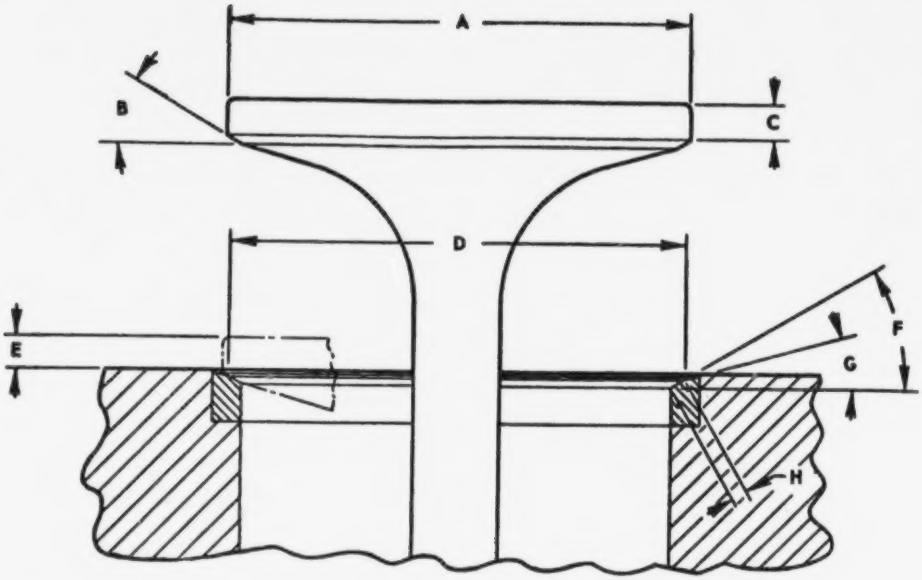
j. Discard all gaskets.

## 8-185. REPAIR.

a. When results of inspections in step g., paragraph 8-184 indicate that valves were not properly seated, grind the valve seat or seats using an approved valve seat grinder, and grind the valve or valves, using a suitable valve face grinding machine.

b. After valve seats and/or valve faces have been ground until they are smooth and concentric with valve guides, clean all parts with an approved cleaning solvent, and dry thoroughly.

c. If exhaust and intake valve faces (53 and 54, figure 8-44) and valve seat inserts (57 and 58) have been ground for proper



VALVE AND VALVE SEAT SPECIFICATIONS

A – VALVE HEAD DIAMETER. B – VALVE FACE ANGLE. C – MINIMUM VALVE LIP THICKNESS. D – OUTSIDE DIAMETER OF VALVE SEAT FACE. E – CLOSED VALVE PROJECTION. F – VALVE SEAT FACE ANGLE. G – ANGLE TO GRIND INSERT SEAT FACE TO REDUCE MAXIMUM SEAT DIAMETER. H – MAXIMUM PERMISSIBLE VALVE SEAT WIDTH.

| | INLET | EXHAUST |
|---|---|---|
| A | 1.766/1.776 INCHES | 1.641/1.651 INCHES |
| B | 44-1/4 DEGREES | 44-1/4 DEGREES |
| C | 0.0716 INCH | 0.0720 INCH |
| D | 1.714/1.7456 INCHES | 1.589/1.6210 INCHES |
| E | 0.075/0.133 INCH | 0.075/0.133 INCH |
| F | 45 DEGREES | 45 DEGREES |
| G | 15 DEGREES | 15 DEGREES |
| H | 0.060 INCH | 0.074 INCH |

Figure 8-45. Valve and valve seat specifications

seating, the dimensional specifications outlined in figure 8-45 must be met. If dimensions are unacceptable, exhaust and intake valves (53 and 54) and valve seat inserts (57 and 58) must be replaced. Use a suitable valve seat extractor to replace valve seat inserts.

d. To install new valve seat inserts that have been worn beyond acceptable grinding tolerances, observe the following: (This does not include valve seat inserts that are loose.)

1. Clean cylinder head with an approved cleaning solvent, and dry thoroughly.

2. Refer to table 1-1 to ensure that head counterbores meet allowable limits before installing inserts.

3. Immerse the cylinder head in water heated to 180°F to 200°F for at least 30 minutes.

4. Rest the cylinder head upside down on a bench, and lay a new insert in counterbore, valve seat up. This must be done quickly while the cylinder head is hot and the insert is cold (room temperature).

5. Using an approved valve seat insert installation tool, drive insert down tight into counterbore.

6. Grind the new valve seat insert to the minimum allowable limit of the valve seat insert tolerances shown in table 1-1.

e. To replace a loose valve seat insert, the insert counterbore must be enlarged to accept the next standard oversize insert. After enlarging counterbore, refer to preceding step d. for insert installation procedure.

## 8-186. REASSEMBLY.

Refer to figure 8-44 and reassemble cylinder head and valve mechanism group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Lubricate exhaust and intake valves (53 and 54, figure 8-44) stems and valve guides (55) prior to installation.

b. If removed, install inserts (57 and 58) into cylinder head assembly (49) using a suitable installing tool.

c. Torque chamber assemblies (45) from 145 to 150 foot pounds.

d. Lubricate cylinder head retaining bolts (28 and 30) with clean SAE 30 engine oil. Install bolts and tighten in the numerical order and step sequence defined in figure 8-46.

## 8-187. INSTALLATION.

a. Installation of cylinder head and valve mechanism group is accomplished during reassembly (paragraph 8-186).

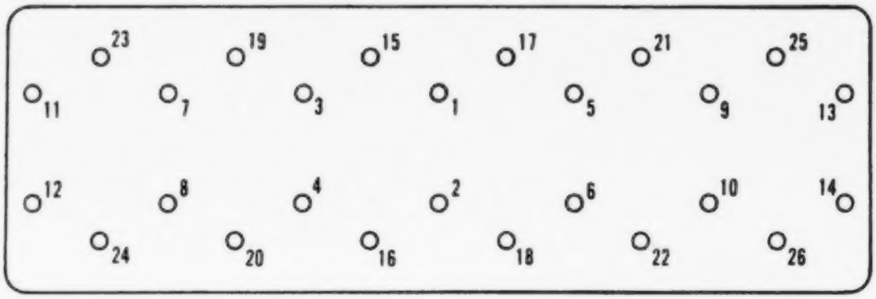
b. Refer to Operator and Organizational Maintenance Manual and adjust valve lash.

c. Install camshaft group (paragraph 8-203).

d. Install turbocharger group (paragraph 8-76).

e. Install aftercooler group (paragraph 8-163).

f. Refer to Operator and Organizational Maintenance Manual and install housing front roof.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CYLINDER HEAD

| | |
|---|---|
| STEP 1 - TIGHTEN ALL BOLTS IN NUMERICAL ORDER TO | 200 FT. LBS. |
| STEP 2 - RETIGHTEN ALL BOLTS IN NUMERICAL ORDER TO | 320 TO 340 FT. LBS. |
| STEP 3 - RETIGHTEN ALL BOLTS IN NUMERICAL ORDER (HAND TORQUE ONLY) TO | 320 to 340 FT. LBS. |

Figure 8-46. Tightening sequence for cylinder head

## Section XXV. FLYWHEEL AND FLYWHEEL HOUSING GROUP

### 8-188. GENERAL.

The flywheel and flywheel housing group is mounted on the rear of the cylinder block. The flywheel and flywheel housing group consists of a cast housing flywheel, ring gear, and engine support brackets. The ring gear is shrink-fitted to the rim of the flywheel. The purpose of the flywheel is to provide a mass at the end of the crankshaft to smooth out power impulses and reduce variation in rotative speed; and to provide a mounting surface for the generator shaft coupling. The ring gear provides a place for starting motor engagement when cranking the engine. The flywheel housing also provides a machined surface to mount the generator housing. Special brackets are bolted to the housing pads to provide support for the engine when the generator is removed for repair. The flywheel housing also provides a counterbore for locating the rear main oil seal.

### 8-189. REMOVAL.

a. Remove engine assembly (paragraph 2-8).

b. Refer to Operator and Organizational Maintenance Manual and remove starter motor and turbocharger.

Removal of flywheel and flywheel housing group is accomplished during disassembly (paragraph 8-190).

### 8-190. DISASSEMBLY.

Refer to figures 8-47 and 8-42 and disassemble flywheel and flywheel housing in the order of index numbers assigned. Pay particular attention to the following:

a. Remove spacer (item 15, figure 2-5 with a suction cup.

b. Scribe a mark on flywheel and crankshaft to show a relative position between the two parts.

c. Remove two of the flywheel retaining bolts (14) and lock washers (15) and install two pilot studs 3/4" - 16NF x 7" (19.05 mm - 16NF x 177.8 mm) long.

WARNING

The flywheel assembly is not dowelled to crankshaft. When removing the assembly, item (16), hold firmly against the crankshaft by hand to prevent it from slipping off end of crankshaft.

d. To lift flywheel assembly (16) install two 5/8" - 13NC (15.875 mm - 13NC) forged eye bolts in the flywheel.

e. Attach chain hoist and sling to flywheel assembly (16) and remove the remaining bolts (14) and lock washer (15).

f. Remove flywheel from engine.

NOTE

Do not remove gear (17) from flywheel assembly (16) unless damage to ring gear (17) of flywheel (18) is evident.

g. Discard crankshaft seal.

### 8-191. CLEANING.

a. Clean parts with an approved cleaning solvent and dry thoroughly.

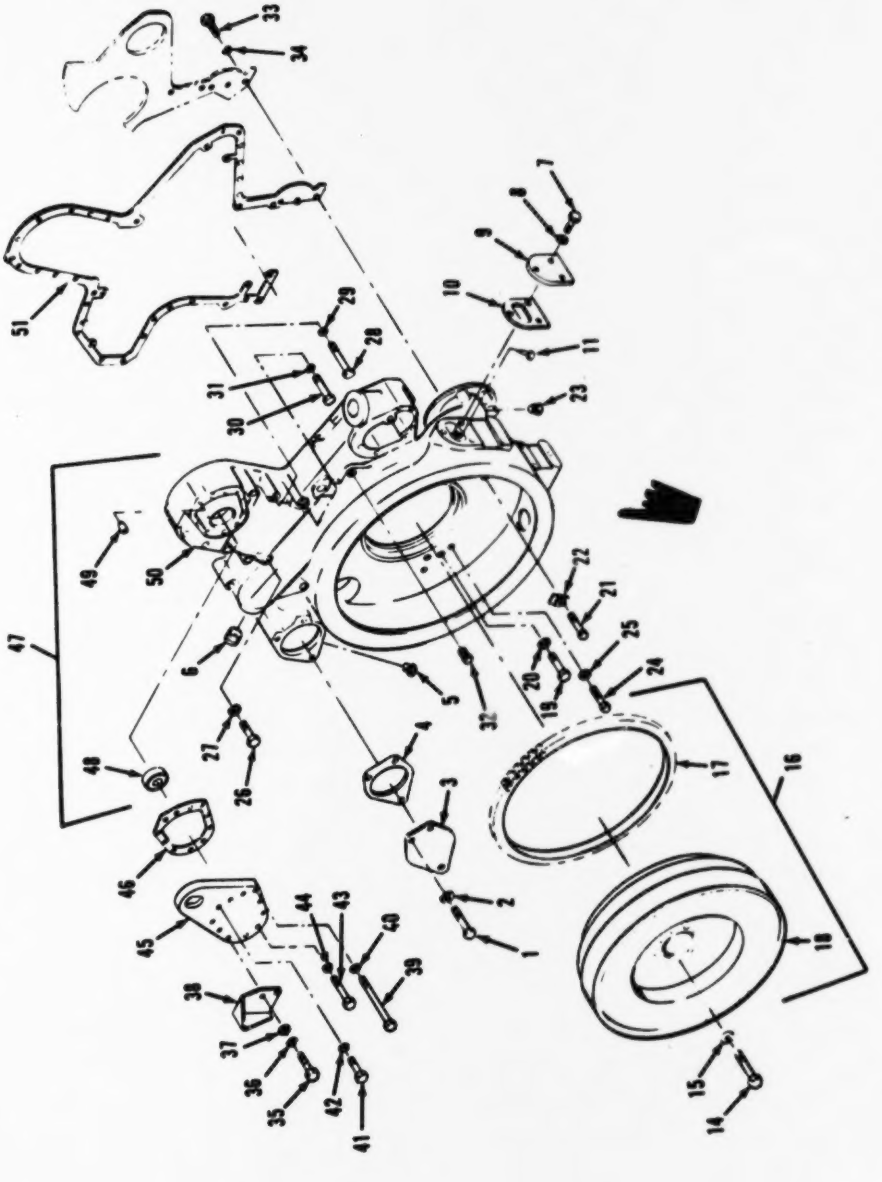
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Figure 8-47. Flywheel and flywheel housing group, exploded view

Legend to figure 8-47:

1. Bolt (3)
2. Lock washer (3)
3. Cover
4. Gasket
5. Plug
6. Plug
7. Bolt (3)
8. Lock washer (3)
9. Cover
10. Gasket
11. Pointer
12. Not used
13. Not used
14. Bolt (9)
15. Washer (9)
16. Flywheel assembly
17. Gear
18. Flywheel
19. Bolt (4)
20. Lock washer (4)
21. Bolt
22. Lock
23. Plug
24. Bolt (3)
25. Lock washer (3)
26. Bolt
27. Washer
28. Bolt (6)
29. Lock washer (6)
30. Bolt
31. Lock washer
32. Plug
33. Bolt (11)
34. Lock washer (11)
35. Bolt (2)
36. Lock washer (2)
37. Washer (2)
38. Bracket
39. Bolt (3)
40. Lock washer (3)
41. Bolt
42. Lock washer
43. Bolt (5)
44. Lock washer (5)
45. Lifting eye
46. Gasket
47. Housing assembly
48. Bearing
49. Pin
50. Housing
51. Gasket

b. Remove rust from ring gear, using a stiff brush. Wash ring gear with solvent and dry thoroughly.

c. Flush out turbo drain port in housing with solvent and dry with low pressure compressed air.

### 8-192. INSPECTION.

a. Inspect flywheel housing for cracks. Replace cracked flywheel housing.

b. Check machined gasket surface at ring of flywheel housing for nicks and burrs.

c. Inspect threaded holes for damaged threads.

d. Inspect ring gear teeth for nicks, burrs, cracks, and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of the gear. Replace ring gear if cracked or if teeth are broken.

e. Inspect ring gear for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

f. Inspect shaft couplings counter bore on flywheel for burred edges or an indication that shaft couplings on generator do not seat properly.

g. Discard gaskets.

### 8-193. REPAIR.

a. Remove minor nicks and burrs from flywheel housing and ring gear teeth, using a suitable file or hone.

b. Repair minor thread damage using a suitable thread chaser.

c. Replace a defective ring gear as follows:

1. Cut or press off defective ring gear.

CAUTION

Under no circumstances should the ring gear (17, figure 8-47) be heated over 600°F(316°C) as excessive heating may destroy the original heat treatment. Do not heat ring gear in one area.

2. Heat new ring gear to a maximum of 600°F (316°C). Use a torch and apply heat evenly around diameter of ring gear.

3. Install ring gear with chamfered portion of ring gear teeth facing toward starter pinion or to backside of flywheel. Gear must be flush with flywheel shoulder.

CAUTION

Be careful to remove only the burred material on the edge of the shaft coupling counterbore.

d. Remove sharp edges and burrs from shaft coupling counterbore in flywheel using a suitable file.

### 8-194. REASSEMBLY.

Refer to figure 8-47 and reassemble flywheel and flywheel housing group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Bottom edges of housing gasket (51) that contacts oil pan plate must be cut square and flush with oil pan plate before flywheel housing is secured to crankcase.

b. Install two suitable pilot studs 5/8 - 16 x 2-1/2 inch (63.5 mm) in crankshaft flange to act as guide pins while flywheel housing is hoisted into position and located on dowel pins.

c. Install crankshaft seal (29, figure 8-55) using suitable tools. Refer to figure 8-48.

d. Torque flywheel housing bolts to 160 foot-pounds (22.128 kg - meters).

e. Before locating flywheel assembly (16, figure 8-47) on crankshaft, make sure that alignment scribe lines are lined up.

f. Torque flywheel retaining bolts (14) from 230 to 300 foot pounds (31.809 to 41.49 kg - meters).

g. Check flywheel and flywheel housing for parallelism and concentricity, using suitable dial indicators as follows:

1. Remove fuel injectors, this will relieve engine compression when rotating crankshaft.

2. When making checks, position dial indicators straight and square as shown in figure 8-49 and 8-50 and make sure indicators have adequate travel in each direction.

3. Using a suitable board, apply pressure to front end of crankshaft to make sure end play is in one direction only.

4. Perform concentricity check as shown in figure 8-49. Adjust dial indicator to read zero at twelve o'clock position. Apply continuous pressure to front end of crankshaft and using engine barring device, rotate crankshaft one full revolution, taking readings at 45 degree (.785 Radian) intervals (8 readings each on flywheel housing (47, figure 8-47). Ensure end play is in one direction only before recording each reading to ensure accuracy. The maximum total indicator reading must not exceed 0.012 inch (.304 mm).

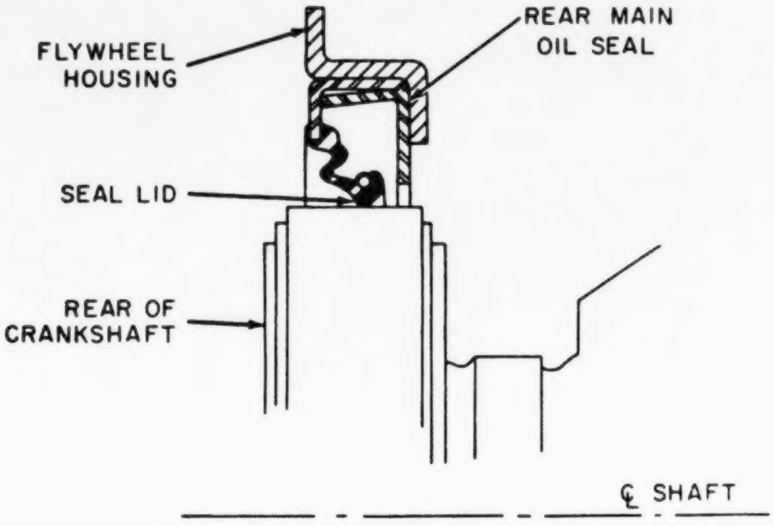

Figure 8-48. Installing crankshaft seal

5. If the flywheel housing (47) bore run-out is excessive, remove flywheel (16) and loosen flywheel housing attaching bolts slightly and tap the flywheel housing (47) with a soft hammer in the required direction until the run-out is within limits. Retighten the attaching bolts, install flywheel (16) and recheck the run-out.

6. Perform parallelism check as shown in figure 8-60. Adjust dial indicator to read zero at twelve o'clock position. Apply continuous pressure to front end of crankshaft and using engine barring device, rotate crankshaft one full revolution, taking readings at 45 degree intervals (8 readings each on flywheel face). Ensure end play is in one direction only before recording each reading to ensure accuracy. The maximum total indicator reading must not exceed 0.006 inch.

7. If the flywheel housing (47, figure 8-47) face run-out is excessive, remove flywheel housing (47), and check for dirt or foreign material (such as old gasket material) between flywheel housing (47) and crankshaft flange. Install flywheel housing (47) and recheck the run-out.

### 8-195. INSTALLATION.

a. Installation of the flywheel and flywheel housing is accomplished during reassembly (paragraph 8-194).

b. Refer to Operator and Organizational Maintenance Manual and install starter motor and turbocharger.

c. Install engine assembly (paragraph 2-8).

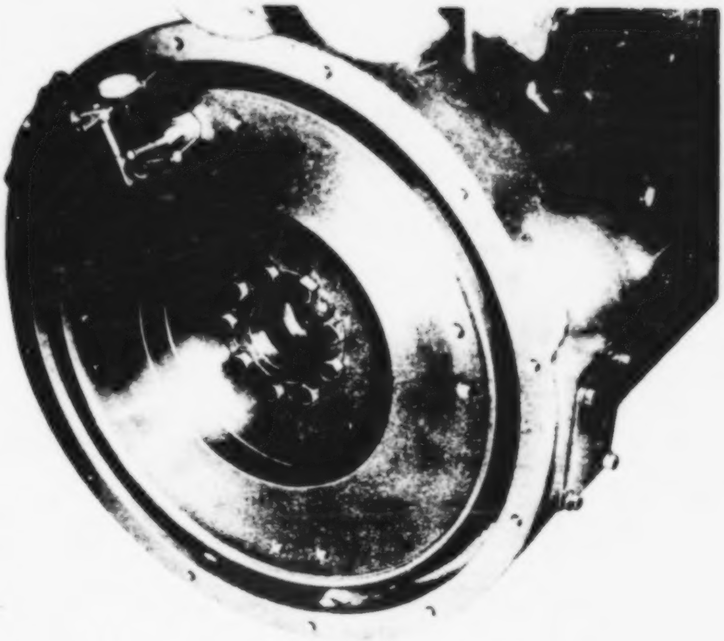

Figure 8-49. Flywheel housing bore concentricity check

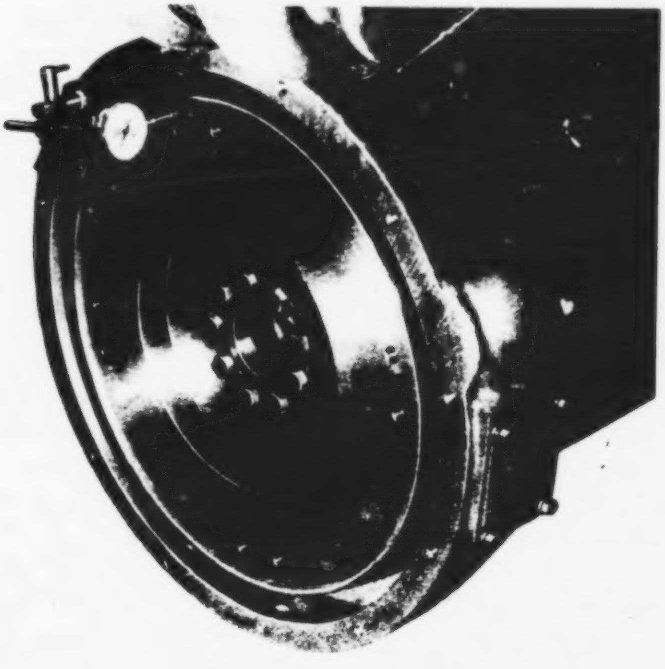

Figure 8-50. Flywheel housing face parallelism check

## Section XXVI. CAMSHAFT GROUP AND RELATED PARTS

### 8-196. GENERAL.

The overhead camshafts are located on top of the cylinder head; they are driven by the camshaft drive gears. The camshaft group consists of block assemblies, intake camshaft assembly and exhaust camshaft assemblies. The cams are forged integrally with the shafts. As the camshafts turn, the cams actuate the inlet and exhaust valves at the timed sequence that effects proper engine operation.

### 8-197. REMOVAL.

a. Refer to Operator and Organizational Maintenance Manual, and remove housing front roof.

b. Remove turbocharger group (paragraph 8-70).

c. Removal of the camshaft group is accomplished during disassembly (paragraph 8-198).

### 8-198. DISASSEMBLY.

Refer to figure 8-51 and disassemble camshaft group and related parts in the order of index numbers assigned. Pay particular attention to the following:

a. Rotate crankshaft until No. 1 cylinder is at top center on compression stroke.

CAUTION

Using a lint-free cloth, plug oil return holes in cylinder head below camshaft. This precludes small parts dropping into engine block.

b. Position camshaft phasing gear timing marks together, and in a horizontal plane as shown in figure 8-52.

NOTE

Camshaft drive cover plate must be removed to move shaft back to free camshafts.

c. Using a suitable bar, pry the camshaft driveshaft toward rear of engine until driveshaft clears camshaft.

CAUTION

To avoid piston and valve interference, do not attempt to rotate crankshaft with camshafts installed and camshaft driveshaft removed.

d. Using a suitable hoist and sling, remove camshafts.

### 8-199. CLEANING.

Clean components with an approved cleaning solvent and dry thoroughly.

### 8-200. INSPECTION.

a. Refer to table 1-1 and, using a suitable micrometer and feeler gauge, check for excessive wear as follows:

1. Rear bearing journal diameter and bearing to hournal clearance.

2. Front and intermediate bearing journal diameters and bearing to journal clearance.

3. Camshaft clearance.

4. If journal diameter, bearing to journal clearance or camshaft end clearance are not within the allowable tolerances indicated in table 1-1, replace camshaft and/or camshaft bearings.

b. Inspect each camshaft gear for nicked, burred or cracked gear teeth. If cracked, replace gear.

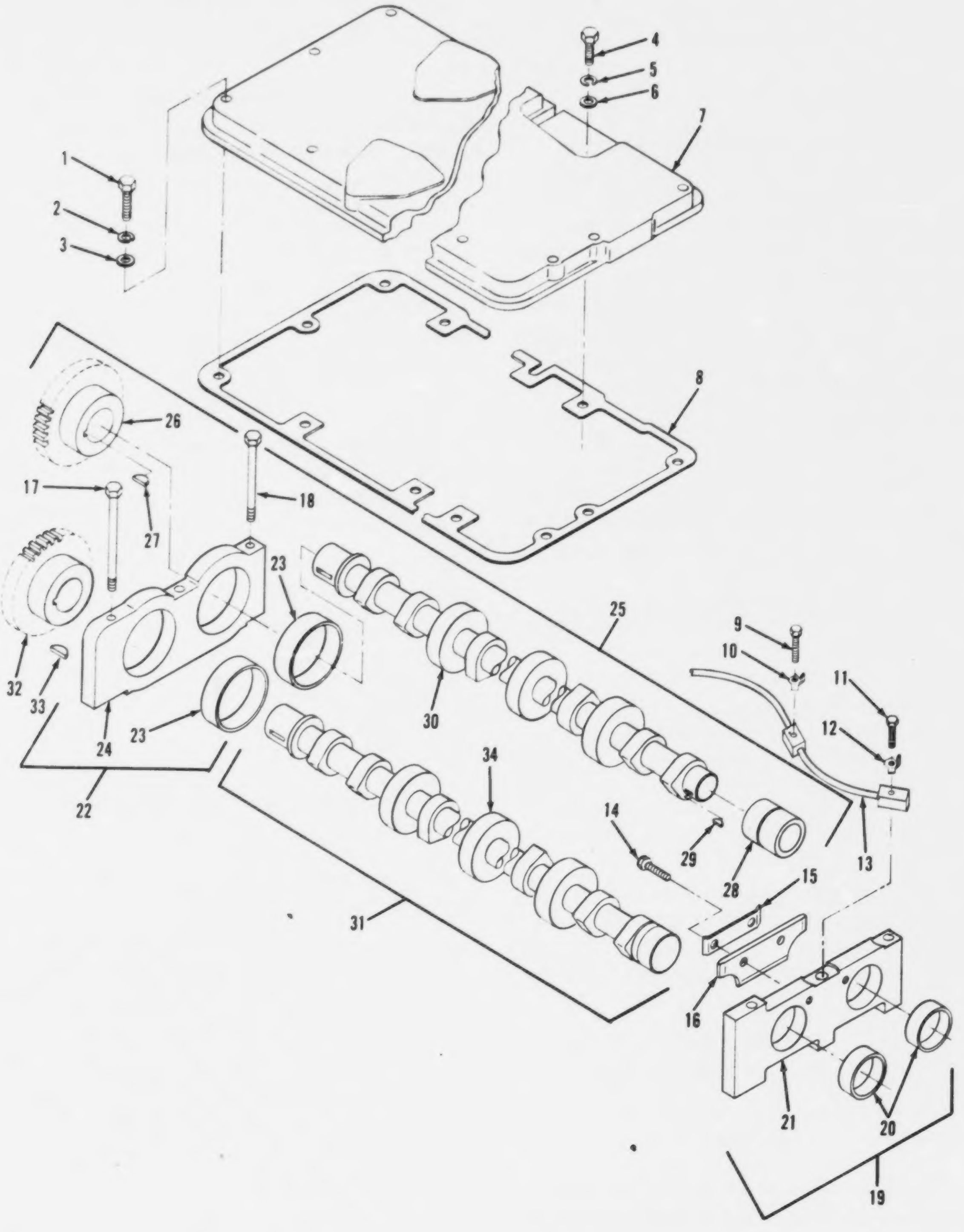
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Figure 8-51. Camshaft group and related parts, exploded view

**Legend to figure 8-51:**

1. Bolt (14)
2. Lock washer (14)
3. Washer (14)
4. Bolt (5)
5. Lock washer (5)
6. Washer (5)
7. Cover
8. Gasket
9. Bolt (6)
10. Lock (6)
11. Bolt
12. Lock
13. Tube assembly
14. Bolt (2)
15. Lock
16. Plate
17. Bolt (7)
18. Bolt (7)
19. Block assembly
20. Bearing (2)
21. Block
22. Block assembly (6)
23. Bearing (2)
24. Block (6)
25. Exhaust camshaft assembly
26. Gear
27. Key
28. Collar
29. Key
30. Camshaft
31. Intake camshaft assembly
32. Gear
33. Key
34. Camshaft

c. Inspect camshafts for cracks and distortion. If defective, replace camshaft.

## 8-201. REPAIR.

Repair minor nicks and burrs on camshaft gears using a suitable file or hone.

## 8-202. REASSEMBLY.

Refer to figure 8-51 and reassemble camshaft group and related parts in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Adjust all camshaft followers in cylinder head to provide maximum valve clearance.

b. Align camshaft phasing gear timing marks as shown in figure 8-52.

c. Apply graphite grease to camshaft lobes prior to installing camshafts.

d. Attach suitable hoist and sling and position camshafts on cylinder head. Make sure blocks are seated properly on locating dowels.

CAUTION

Never attempt to install camshafts if the No. 1 piston is not at top dead center compression stroke. Damage to the engine may result if crankshaft is improperly positioned.

e. Install inner fuel injection lines. Tighten retaining nuts to 25 to 35 foot pounds (3.457 to 4.841 kg - meters).

f. Position camshaft driveshaft in camshaft with the blind spline on top.

g. Position rear lifting eye, and install and tighten lifting eye retaining bolts.

h. Adjust inlet valve clearance to 0.018 inch (.4572 mm) and exhaust valve clearance to 0.036 inch (.9144 mm)

NOTE

See paragraph 3-86 of service manual for valve adjustment instructions.

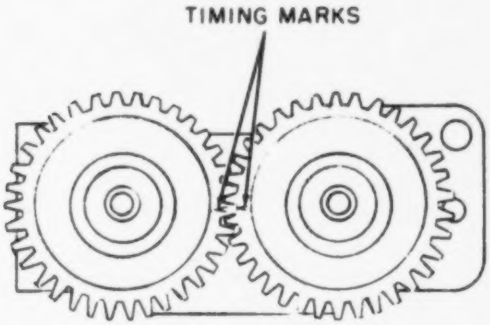

Figure 8-52. Timing marks for camshaft phasing gears

8-203. INSTALLATION.

a. Installation of camshaft group and related parts is accomplished during reassembly (paragraph 8-202).

b. Install turbocharger group (paragraph 8-76).

c. Refer to Operator and Organizational Maintenance Manual and install housing front roof.

## Section XXVII. CAMSHAFT DRIVE GROUP

### 8-204. GENERAL.

The camshaft drive group consists of a drive gear, idler gear, and a thrust washer. The camshaft drive group drives the camshafts.

### 8-205. REMOVAL.

a. Remove engine assembly (paragraph 2-8).

b. Remove turbocharger group (paragraph 8-70).

c. Remove flywheel and flywheel housing group (paragraph 8-189).

d. Removal of the camshaft drive group is accomplished during disassembly (paragraph 8-206).

### 8-206. DISASSEMBLY.

Refer to figure 8-53 and disassemble the camshaft drive group.

### 8-207. CLEANING.

Clean components with an approved cleaning solvent and dry thoroughly.

### 8-208. INSPECTION.

a. Inspect drive shaft splines for nicks and burrs.

b. Inspect idler and drive gear for nicks, burrs or cracked gear teeth.

c. Inspect bearings for scoring, pitting or scratches.

d. Inspect cage and shaft for cracks and other damage.

e. Inspect thrust washers for scoring, cracks or other damage.

f. Discard gasket.

### 8-209. REPAIR.

a. Repair minor nicks and burrs using a suitable file or hone.

b. Replace defective gear.

c. Replace scored or damaged bearings.

### 8-210. REASSEMBLY.

Refer to figure 8-53 and reassemble the camshaft drive group in the reverse sequence of index numbers assigned. Pay particular attention to the following:

a. Align camshaft drive gear with timing mark on idler gear. Refer to figure 8-39.

### 8-211. INSTALLATION.

a. Installation of the camshaft drive group is accomplished during reassembly (paragraph 8-210).

b. Install flywheel and flywheel housing group (paragraph 8-195).

c. Install turbocharger group (paragraph 8-76).

d. Install engine assembly (paragraph 2-8).

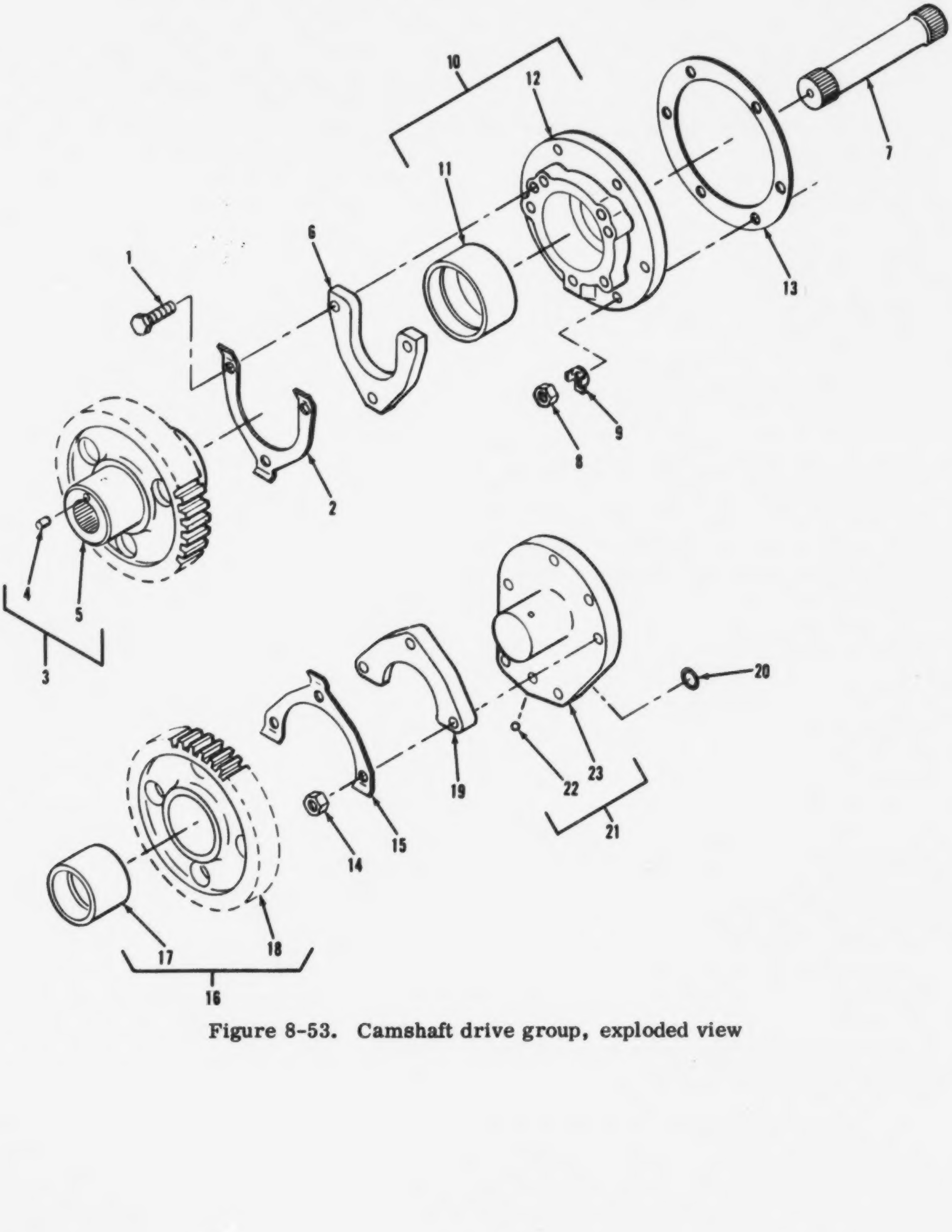
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Figure 8-53. Camshaft drive group, exploded view

Legend to figure 8-53:

1. Bolt (3)
2. Lock
3. Gear assembly
4. Pin
5. Gear
6. Washer
7. Shaft
8. Nut (6)
9. Lock (6)
10. Cage assembly
11. Bearing
12. Cage
13. Gasket
14. Nut (3)
15. Lock
16. Gear assembly
17. Bearing
18. Gear
19. Washer
20. Seal
21. Shaft assembly
22. Ball
23. Shaft

## Section XXVIII. CONNECTING RODS AND PISTONS GROUP

### 8-212. GENERAL.

The connecting rods and pistons group is located in the cylinder block. The connecting rods and pistons group consists of piston assemblies, connecting rod assemblies, bearings, pins, and retainers. The piston assemblies are attached to the crankshaft by connecting rods.

### 8-213. REMOVAL.

a. Remove turbocharger group (paragraph 8-70).

b. Remove fuel injection lines (paragraph 8-134).

c. Remove camshaft group and related parts (paragraph 8-197).

d. Remove cylinder head and valve mechanism group (paragraph 8-181).

e. Remove oil pan group and related parts (paragraph 8-165).

f. Remove oil pump group (paragraph 8-173).

g. Removal of connecting rods and pistons is accomplished during disassembly (paragraph 8-214).

### 8-214. DISASSEMBLY.

Refer to figure 8-54 and disassemble connecting rods and pistons group in the order of index numbers assigned. Pay particular attention to the following:

a. Prior to removing piston, note the condition at the top of cylinder liner. If a carbon ridge is present, it must be removed using a suitable ridge reamer.

b. Rotate crankshaft until the connecting rod and piston to be removed is at top dead center. Carefully remove each connecting rod and piston by pushing it out through top of cylinder.

c. Using a suitable retaining ring remover, remove retaining rings (7). Using a suitable drift, drive out piston pin (8).

d. Using suitable tools, drive out bushing (10) from connecting rod (11).

e. Tag each bearing halve (2) connecting rod assembly and piston assembly indicating which cylinder they were removed from.

f. Use a suitable piston ring expander to remove piston rings (4, 5, and 6) from the pistons (9).

### 8-215. CLEANING.

a. Clean parts with an approved cleaning solvent and dry thoroughly.

CAUTION

Do not use broken piston rings or carbon scrapers on ring lands since this practice can result in cutting sides of grooves. Be sure bottom of each ring groove is clean and oil return holes in oil ring groove are open.

b. If pistons have carbon on them, soak pistons in cold water overnight and then let them dry (preferably in sunlight).

Most of the carbon can then be removed with a hardwood stick.

### 8-216. INSPECTION.

a. Refer to table 1-1 and inspect parts for dimensional tolerances. Replace defective parts.

b. Inspect piston for burned condition, cracks, distortion, galling, or any other defects. Replace defective piston.

c. Inspect piston pins and rod bearings for scoring, galling, distortion, or cracks. Replace defective bearings.

d. Inspect connecting rod for cracks, breaks, or distortion. Replace defective connecting rod.

NOTE

Bent rods should be discarded. Do not attempt to align rods by bending. Abrasive materials may roll around between bearings (8) and crankshaft journals causing scratches in the bearing without actually becoming embedded in the aluminum. Such scratches are not necessarily harmful and do not indicate that bearings (8, figure 8-54) should be replaced.

e. To measure clearance and gap for each piston ring (10, 11, and 12), insert a piston (13) in cylinder bore in the inverted position. Insert each piston ring, one at a time, about two inches down in the cylinder bore and bring the bottom edge of the piston (13) up against the ring to square the ring in the cylinder bore. Check gap with a feeler gauge. If gap clearance for any ring is not as specified in table 1-1, the ring must be filed or honed to specification, or replaced.

### 8-217. REPAIR.

a. When installing a new bearing (6) into the connecting rod, the joint on the diameter of the bearing must be at right angles (90 ± 10 degrees, either left or right) of the vertical centerline of the connecting rod. After pressing new bearing in place machine accurately to dimensions in table 1-1.

b. Connecting rod bearings (8) should always be replaced as a set (two halves make a set). If inspection of one bearing shell indicates minimum thickness, then replace all six connecting rod bearing shells.

### 8-218. REASSEMBLY.

Refer to figure 8-54 and reassemble connecting rods and pistons group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Reassemble rod (11) on piston (9) so that the etched cylinder number on rod (11) is on the same side as the "V" mark in the piston (9).

b. Use a suitable piston ring expander to install piston rings (4, 5, and 6) on pistons (9). The two compression rings are marked with the word "UP" and numbers (1 or 2). The rings should be installed with the word "UP" towards the top of the piston with number 1 being the top ring.

c. Lubricate bearings (10 and 2), piston rings (4, 5, and 6), and the liner walls with clean engine oil.

d. Compress piston rings (4, 5, and 6) with a suitable ring compressor tool

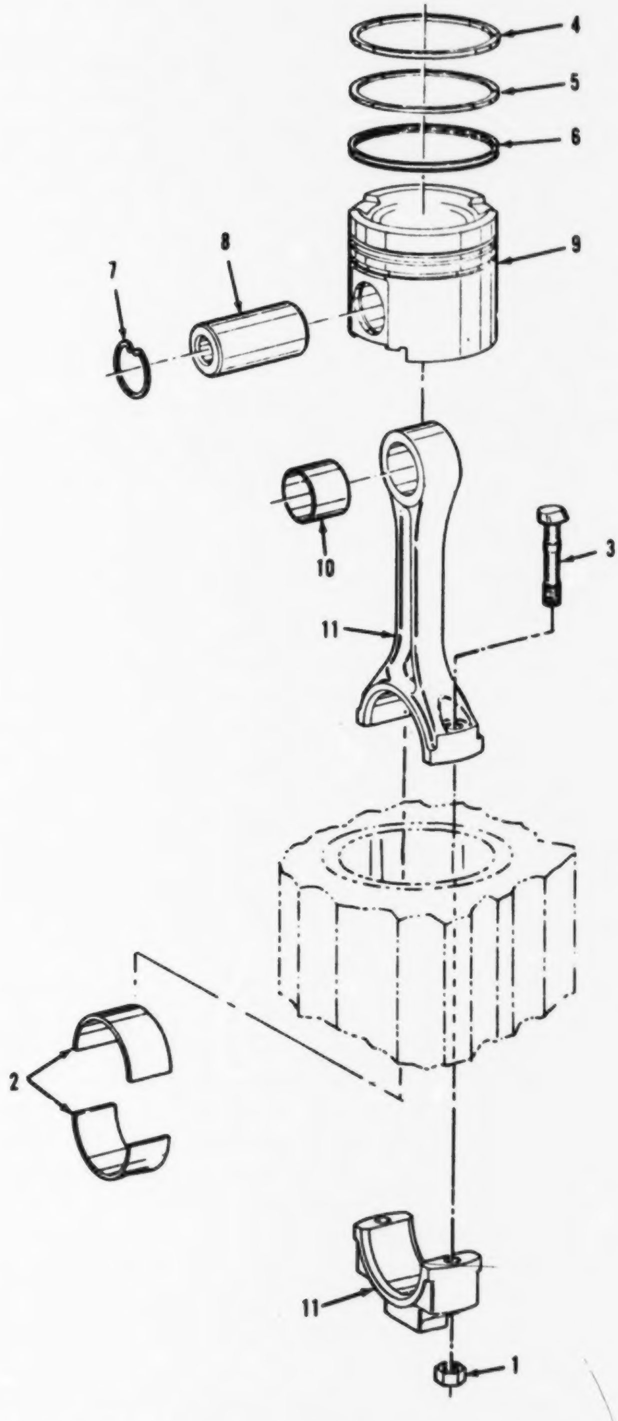
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Figure 8-54. Connecting rods and pistons group, exploded view

Legend to figure 8-54:

1. Nut (2)
2. Bearing (6)
3. Bolt (2)
4. Ring
5. Ring
6. Ring
7. Ring (12)
8. Pin (6)
9. Piston
10. Bearing
11. Rod

and install piston (9) so that the "V" mark on top of the piston lines up to the "V" mark on top of the block.

e. When assembling lower bearing cap (11) to connecting rod, make sure that protruding tab on back of each bearing half (2) lines up with corresponding recess in connecting rod and bearing cap (11).

f. Guide lower end of each connecting rod (11)over crankshaft journal so as not to damage crankshaft bearing surface.

g. Check connecting rod bearing clearance as follows:

1. Place an approved piece of soft plastic measuring strip (plastigage or equal) between crankshaft journal and lower bearing half, on all six connecting rod assemblies.

2. Install lower bearing caps (11, figure 8-54), bolts (3) and nuts (1). Lubricate bolt threads with clean OE/HDO 30 engine oil. Tighten nuts (1) initially from 45 to 55 foot pounds (6.223 to 7.606 kg - meters) torque. Mark nuts (1) and cap (11) then tighten an additional 180 degrees (3.14 Radian) from marks.

3. Remove caps (11) and bearings one at a time and measure thickness of plastic strips. The measurement represents the bearing clearance. If the maximum clearance exceeds 0.010 inch (.254 mm), replace connecting rod bearings. It would be advisable to replace all rod bearings (2) at this time.

NOTE

Excessive bearing clearance can also be an indication of crankshaft surface being out-of-round.

h. Install lower bearing caps (11), bolts (3) and nuts (1). Lubricate bolt threads with clean OE/HDO engine oil. Tighten nuts (1) initially from 45 to 55 foot pounds (6.223 to 7.606 kg - meters) torque. Mark nuts (1) and cap (11), then tighten an additional 180 degrees (3.14 Radians) from mark.

## 8-219. INSTALLATION.

a. Installation of the connecting rods and pistons group is accomplished during reassembly (paragraph 8-218).

b. Install oil pump group (paragraph 8-179).

c. Install oil pan group and related parts (paragraph 8-171).

d. Install cylinder head and valve mechanism group (paragraph 8-187).

e. Install camshaft group and related parts (paragraph 8-203).

f. Install fuel injection lines (paragraph 8-140).

g. Install turbocharger assembly (paragraph 8-76).

## Section XXIX. CRANKSHAFT, DAMPER AND SUPPORT GROUP

### 8-220. GENERAL.

The crankshaft, damper and support group consists of a vibration damper assembly, support assembly and a crankshaft assembly. The crankshaft group and main bearing assemblies consist of a crankshaft assembly, main bearings, plates, gear and plugs. The end thrust of the crankshaft is taken up by flanges on the lower half of the rear main bearing. Counterweights are forged integrally with the crankshaft and are drilled to obtain shaft balance. The crankshaft timing gear is pressed on the front of the crankshaft. The main bearings and caps support the crankshaft in the cylinder block.

### 8-221. REMOVAL.

a. Remove engine assembly (paragraph 2-8).

b. Remove fan mounting group (paragraph 8-31).

c. Remove turbocharger group (paragraph 8-70).

d. Remove flywheel and flywheel housing (paragraph 8-189).

e. Remove oil pan group and related parts (paragraph 8-165).

f. Remove oil pump (paragraph 8-173).

g. Remove alternator (paragraph 8-13).

h. Removal of crankshaft, damper and support group is accomplished during disassembly (paragraph 8-222).

### 8-222. DISASSEMBLY.

Refer to figure 8-55 and disassemble crankshaft, damper and support group in the order of index numbers assigned. Pay particular attention to the following:

NOTE

If only main bearing removal is required, perform steps a. through e.

a. Turn engine upside down and support in a suitable fixture.

b. Remove nuts (32 and 36), main bearing caps (34 and 38) and lower bearing halves (35 and 39).

c. Tag each bearing cap as to which main bearing it was removed from.

NOTE

Cylinder block is upside down. The bearing half under the crankshaft is still referred to as the upper bearing half.

d. Place a suitable tool in oil hole in crankshaft, and rotate crankshaft to roll out upper bearing halves (35 and 39). Bearing half must be rolled out tab end first.

e. Place bearing half with its mating bearing half and bearing cap.

NOTE

If crankshaft removal is required, perform steps f. through h.

f. Refer to paragraph 8-214, and remove connecting rod bearing and bearing caps. Tag each cap as to which connecting rod it was removed from.

NOTE

Do not remove crankshaft gear (30, figure 8-55) unless excessive wear or damage is noted.

CAUTION

To protect bearing surfaces from galling, wrap each surface with a clean heavy cloth before attaching cables. When removing main bearing caps, cover cap studs with pieces of rubber hose (or the equivalent) to prevent nicking or scratching crankshaft.

g. Lift crankshaft from block using a suitable web sling around connecting rod journals on crankshaft at cylinder No. 1 and 6. Place crankshaft on suitable bench support.

h. Attach each connecting rod bearing cap and insert to the connecting rod from which they were removed.

CAUTION

With crankshaft removed from block, do not attempt to rotate camshaft gear.

### 8-223. CLEANING.

a. Clean bearing caps and bearing halves in an approved cleaning solvent, and dry thoroughly.

b. Clean crankshaft in an approved cleaning solvent, and dry thoroughly. Lubricate and wrap the bearing journals after cleaning.

c. Clean oil passages in the crankshaft with a small soft brush.

d. Clean all other metal parts in approved solvent and dry using compressed air or a lint free cloth. Remove rust from pulley grooves using a stiff wire brush.

### 8-224. INSPECTION.

a. Inspect threaded parts for thread damage.

b. Inspect crankshaft pulley for cracks and worn grooves.

c. Inspect support assembly and cover for cracks, burred or nicked gasket surfaces. Replace cracked support assembly or cover.

d. Inspect bearing surfaces for scoring, flaring, chipping, and cracks.

e. Inspect main bearing caps for high spots and burrs.

f. Inspect for damaged threads.

g. Refer to table 1-1 and check bearing clearances. If limits are exceeded, replace bearing.

h. Refer to table 1-1 and check bearing to crankshaft clearance as follows:

NOTE

Crankshaft must be moved to upper main bearing halves before inserting plastic strip to lower cap for a correct measurement.

1. Place a small strip of approved plastic (plastigage or equal) between lower bearing half (35 and 39, figure 8-55) and crankshaft. Light grease will hold the plastic strip in position.

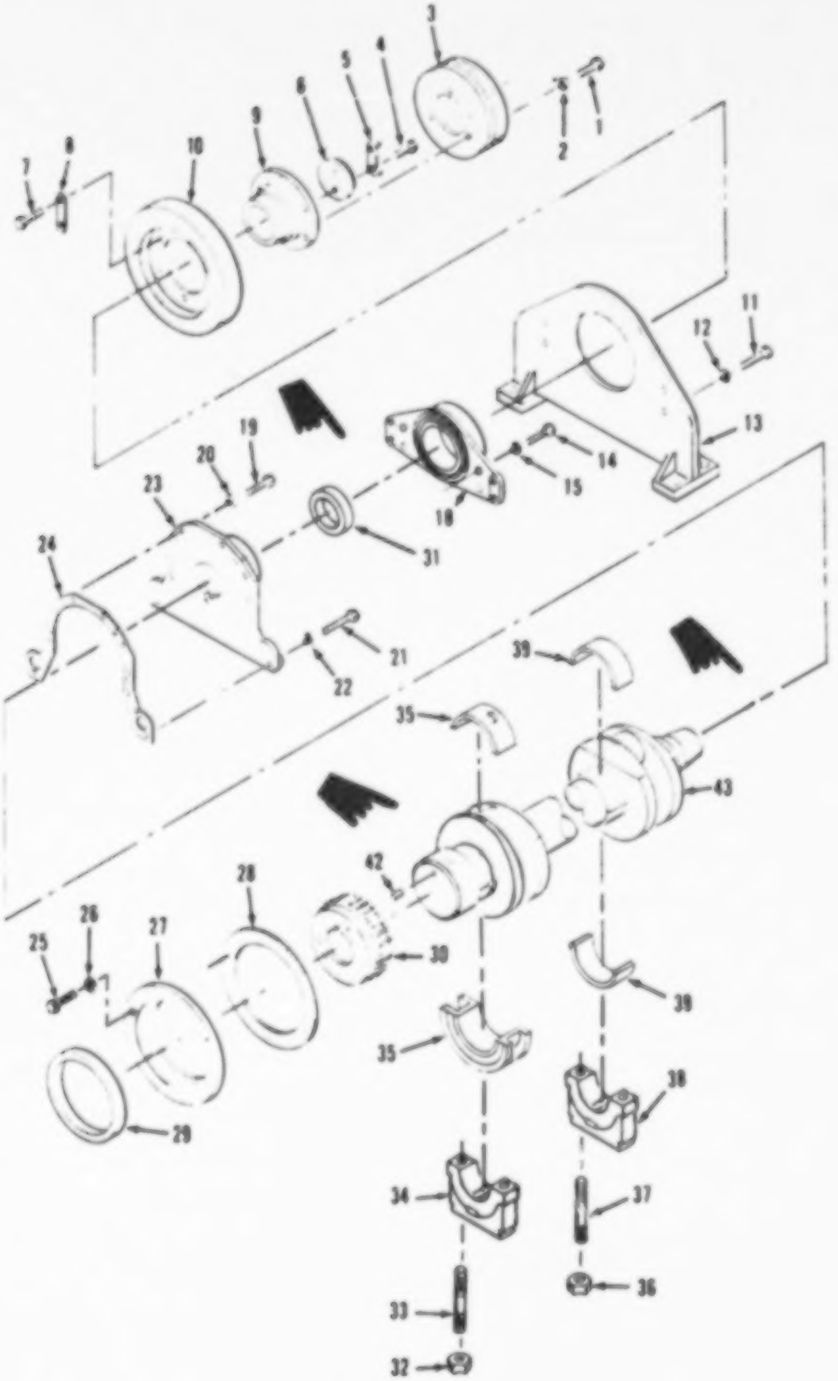
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Figure 8-55. Crankshaft, damper and support group

Legend to figure 8-55:

1. Bolt (6)
2. Lock (6)
3. Pulley
4. Bolt (2)
5. Lock
6. Plate
7. Bolt (6)
8. Lock (3)
9. Hub
10. Damper assembly
11. Bolt (4)
12. Lock washer (4)
13. Support assembly
14. Bolt (4)
15. Lock washer (4)
16. Not used
17. Not used
18. Bushing assembly
19. Bolt (8)
20. Lock washer (8)
21. Bolt (2)
22. Lock washer (2)
23. Cover
24. Gasket
25. Bolt (6)
26. Lock washer (6)
27. Baffle
28. Gasket
29. Seal
30. Gear
31. Seal
32. Nut (2)
33. Stud (2)
34. Cap
35. Bearing assembly
36. Nut (12)
37. Stud (12)
38. Cap (6)
39. Bearing assembly (6)
40. Not used
41. Not used
42. Pin
43. Crankshaft

2. Install main bearing caps (34 and 38) and torque nuts (32 and 36) from 70 to 80 foot pounds (11.064 kg - meters) wet. Mark nuts and caps then tighten each nut an additional 120 degrees (2.094 radian) from mark. Remove main bearing caps (34 and 38) and measure thickness of plastic. This measurement is the main bearing clearance. Clearance should be 0.0035 to 0.0066 inch (.088 to 167 mm) Maximum permissable clearance is 0.009 inch (.2286 mm). If allowable limit is exceeded, replace main bearing and recheck main bearing clearance.

i. Measure crankshaft end clearance by pushing crankshaft (43) as far as it will go to one end of cylinder block and measuring clearance between machine face of crankshaft flange and flange of lower half of rear bearing. Clearance should be 0.006 to 0.018 inch (0.1524 to 0.4572 mm). Maximum permissible end play is 0.035 inch (0.8890 mm).

j. Refer to table 1-1 and, using an outside micrometer, check journal diameters for excessive wear. If maximum allowable wear limits have been exceeded, replace crankshaft.

k. Inspect crankshaft for scoring or galling on crankpin and main journals.

l. Inspect crankshaft gear (30) for broken or chipped teeth. If defective, replace gear.

m. Inspect machined surface, at rear of crankshaft that comes into contact with rear oil seal, for a grooved condition.

n. Discard seals and gaskets.

## 8-225. REPAIR.

a. Remove minor nicks and burrs from bearing caps using a smooth file.

b. Polish machined surface, at rear of crankshaft that comes into contact with rear oil seal, remove slight ridges less than 0.0002 inch (0.00508 mm) in variation, using a crocus cloth wet with fuel oil. Rotate crankshaft and polish the complete circumference of the surface.

c. Remove minor nicks and burrs on metal parts using a suitable file or hone.

d. Repair minor thread damage using a suitable thread chaser.

e. Remove rough edges on pulley grooves with a small hand file.

## 8-226. REASSEMBLY.

Refer to figure 8-55 and reassemble crankshaft, damper and support group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. If crankshaft gear (30) has been removed, install as follows:

1. Install pin (42) in crankshaft (43).

2. Heat gear (30) to 600°F (316°C) maximum and install on crankshaft (43).

b. Clean main bearing surfaces in cylinder block.

NOTE

If results of inspection in paragraph 8-224 indicated excessively worn bearings, replace bearings at this time. Ensure that bearing tab is aligned with the recess in cylinder block. The upper bearing half has an oil groove machined on the inside of bearing with two oil holes. This bearing half can be installed only as an upper main bearing. It is recommended that all bearing halves (35 and 39, figure 8-55) be replaced even if only one bearing must be replaced. When new bearings are installed, proper clearance must be checked as outlined in paragraph 8-224h, steps 1 and 2.

c. Lubricate inside surface of bearings with clean engine oil.

d. Install upper main bearing halves (4 and 39) in cylinder block.

e. Lift crankshaft using a suitable web sling, and install crankshaft with crankshaft gear timing mark aligned with timing mark on camshaft gear if camshaft has not been removed. Refer to figure 8-39.

f. Install plates (6, figure 8-55) with the words "BLOCK SIDE", next to the cylinder block.

g. Install lower bearing halves (35 and 39) bearing caps (34 and 38) with lower bearing half tab mating with tab on upper bearing half. The bearing caps are numbered to ensure installation on the same journal from which they were removed. Torque nuts (32 and 36 as follows:

1. Lubricate thread of studs (33 and 37) with crankcase oil, and tighten nuts (32 and 36) from 70 to 80 foot-pounds (9.681 to 11.064 kg - meters) torque wet.

2. Mark nuts (32 and 36) and caps (34 and 38). Tighten an additional 120 degrees from mark.

h. Refer to paragraph 8-219 and install connecting rod bearings and bearing caps.

8-227. INSTALLATION.

a. Installation of the crankshaft, damper and support group is accomplished during reassembly (paragraph 8-226).

b. Install alternator (paragraph 8-20).

c. Install oil pump (paragraph 8-179).

d. Install oil pan group and related parts (paragraph 8-171).

e. Install flywheel and flywheel housing (paragraph 8-195).

f. Install turbocharger group (paragraph 8-76).

g. Install fan mounting group (paragraph 8-37).

h. Install engine assembly (paragraph 2-8).

## Section XXX. CYLINDER BLOCK AND COVERS GROUP

### 8-228. GENERAL.

The cylinder block and covers group consists of replaceable cylinder liners, plugs, covers, pins, and end plates. The cylinder block assembly consists of a cast cylinder block, which forms the main structural part of the engine. The cylinder block has passages that carry coolant to and around the cylinder liners and other passages that carry lubricating oil to all moving parts. Seals on the liners prevent leakage of coolant into the engine lubricating system. The flywheel housing and the timing gear plate are attached to the rear of the cylinder block, and the water pump is mounted to the flywheel housing. The oil pan and plate attach to the bottom of the cylinder block. A compression gasket forms a tight seal between the cylinder block assembly and the cylinder head assembly.

### 8-229. REMOVAL.

a. Remove engine assembly (paragraph 2-8).

b. Refer to Operator and Organizational Maintenance Manual and remove the following:

1. Engine wiring harness.
2. Air cleaner assembly.
3. Ether atomizer.
4. Lube oil filter group.
5. Manual throttle control.
6. Day tank assembly.
7. Turbocharger group.
8. Starter motor assembly.
9. Alternator assembly.
10. Water pump group.

c. Remove fan mounting group (paragraph 8-31).

d. Remove tachometer drive group (paragraph 8-54).

e. Remove fuel pump group (paragraph 8-62).

f. Remove oil cooler group (paragraph 8-78).

g. Remove hydraulic tank (precise sets only) (paragraph 8-86).

h. Remove hydraulic pump (precise sets only) (paragraph 8-94).

i. Remove hydraulic pump drive group (paragraph 8-101).

j. Remove governor actuator unit (paragraph 8-109).

k. Remove utility governor group (paragraph 8-126).

l. Remove fuel injection group (paragraph 8-134).

m. Remove accessory drive group (paragraph 8-143).

n. Remove exhaust manifold group (paragraph 8-151).

o. Remove aftercooler group (paragraph 8-157).

p. Remove oil pan group and related parts (paragraph 8-165).

q. Remove oil pump group (paragraph 8-173).

r. Remove cylinder head and valve mechanism group (paragraph 8-181).

s. Remove flywheel and flywheel housing group (paragraph 8-189).

t. Remove camshaft drive group (paragraph 8-205).

u. Remove connecting rods and pistons group (paragraph 8-213).

v. Remove crankshaft damper and support group (paragraph 8-221).

## 8-230. DISASSEMBLY.

Refer to figure 8-56 and disassemble cylinder block and covers group in the order of index numbers assigned. Pay particular attention to the following:

Use a suitable puller to remove cylinder liners (67) from cylinder block (99). Mark liners in accordance with cylinders they were removed from.

## 8-231. CLEANING.

a. Clean parts with an approved cleaning solvent, and dry thoroughly.

b. Clean all oil passages with a brush or rod, and use compressed air on passages.

c. Remove rust and scale from outside surface of cylinder liners using a stiff brush.

d. Remove rust and scale from water jacket in cylinder block.

## 8-232. INSPECTION.

a. Refer to table 1-1 and, using a suitable micrometer and feeler gauge, check for excessive wear as follows:

1. Liner counterbore depth.

2. Cylinder line bore.

3. Cylinder liner flange thickness.

4. Install lower main bearing caps, and tighten bolts from 70 to 80 foot-pounds (9.681 to 11.064 kg meters torque. Measure main bearing bore diameter.

5. If allowable limits are exceeded, replace part.

b. Inspect cylinder liners for cracks, scoring, distortion, excessive wear, and other defects.

c. Inspect covers for cracks, breaks, distortion, and other defects.

d. Inspect cylinder bore for an out of round condition.

e. Inspect top of cylinder block for grooving or roughness.

f. Inspect for damaged threads.

g. Discard all gaskets and seals.

## 8-233. REPAIR.

Repair tapped holes that are nicked or burred by retapping with a suitable tap.

## 8-234. REASSEMBLY.

Refer to figure 8-56 and reassemble cylinder block and covers group in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Install new seals (66 and 68) on cylinder liner (67).

b. Coat seals (66 and 68, figure 8-56) and mating bore with liquid soap before installing cylinder liner (67).

NOTE

Cylinder liner shall be installed in same cylinder bore from which it was removed.

c. Position cylinder liner (67, figure 8-56) in bore chamber. Place a suitable plate on top of cylinder liner (67). Use a block of hard wood over the plate and drive cylinder liner (67) into place.

d. Secure cylinder liner (67) in its bore using a suitable crossbar and two 3/4-10NC bolts 3 inches (19.05 mm - 10NC bolts 76.20 mm) long with flat washers as shown in figure 8-57. Tighten bolts evenly as follows:

1. Tighten bolts to 10 foot pounds (1.383 kg - meters).
2. Tighten bolts to 25 foot pounds (3.457 kg - meters).
3. Tighten bolts to 50 foot pounds (6.915 kg - meters).
4. Finally tighten bolts to 70 foot pounds (9.681 kg - meters).

e. Using a suitable depth micrometer, measure cylinder liner (67) projection by measuring down from liner surface contacting the head gasket (38, figure 8-44) to face of the cylinder block (99), figure 8-56). Liner projection must be 0.002 to 0.0076 of an inch (.193 mm) and the four measurements around liner should not vary more than 0.001 inches (.025 mm). The average projection between adjacent cylinders must not vary more than 0.001 inches (.025 mm). If necessary adjust liner projection using available shims, 0.007 (black), 0.008 (red), 0.009 (green), 0.015 (brown or 0.030 (blue).

f. Cylinder block (99) may be pressure tested as follows:

1. Seal off water inlet and outlet holes air tight, using plates and suitable rubber gaskets held in place by bolts.

2. Immerse cylinder block (99) in tank of water. Attach a suitable fitting at one of the water inlet or outlet openings. Apply 60 psi (4.218 kg/sq cm) air pressure to water pocket and observe water in tank for bubbles indicating cracks or leaks.

3. Following pressure test, blow out passages with dry, compressed air.

g. Install cylinder block covers using new gaskets.

## 8-235. INSTALLATION.

a. Installation of cylinder block and covers group is accomplished during reassembly (paragraph 8-234).

b. Install crankshaft damper and support group (paragraph 8-227).

c. Install connecting rods and pistons group (paragraph 8-219).

d. Install flywheel and flywheel housing group (paragraph 8-195).

e. Install cylinder head and valve mechanism (paragraph 8-187).

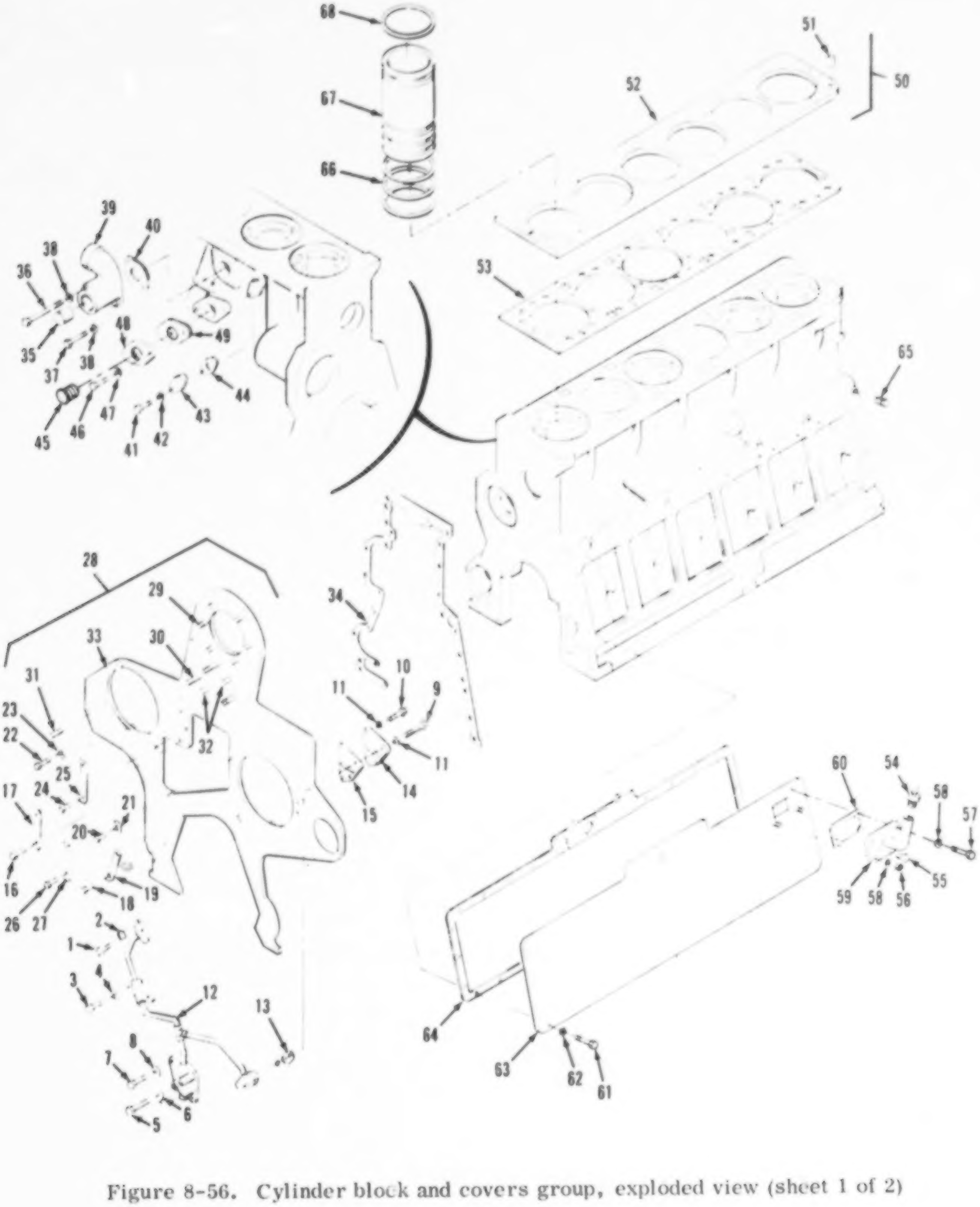
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Figure 8-56. Cylinder block and covers group, exploded view (sheet 1 of 2)

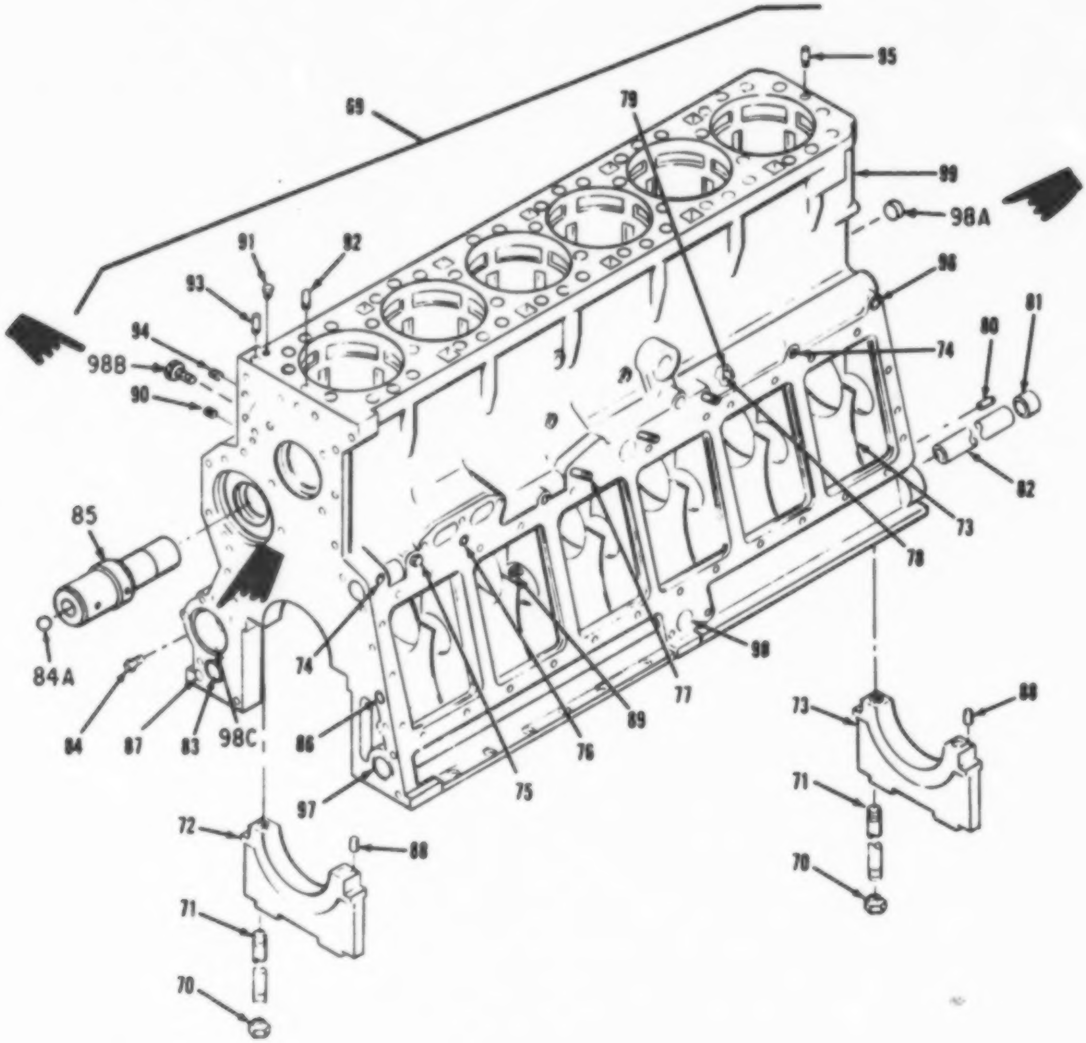
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Figure 8-56. Cylinder block and covers group, exploded view (sheet 2 of 2)

Legend to figure 8-56:

1. Bolt (2)
2. Lock (2)
3. Bolt (3)
4. Lock (2)
5. Bolt (5)
6. Lock
7. Bolt (2)
8. Lock (2)
9. Bolt
10. Bolt (3)
11. Lock washer (4)
12. Tube assembly
13. Gasket
14. Junction
15. Gasket
16. Bolt (2)
17. Lock
18. Bolt (2)
19. Lock
20. Bolt
21. Lock
22. Bolt
23. Lock
24. Bolt (2)
25. Lock
26. Bolt (2)
27. Lock
28. Plate assembly
29. Stud (6)
30. Stud (3)
31. Stud (12)
32. Pin (2)
33. Plate
34. Gasket
35. Plug
36. Bolt
37. Bolt
38. Lock washer (2)
39. Adapter
40. Gasket
41. Bolt (2)
42. Lock washer (2)
43. Cover
44. Gasket
45. Plug
46. Bolt (2)
47. Lock washer (2)
48. Flange
49. Gasket
50. Plate assembly
51. Pin
52. Plate
53. Gasket
54. Cap
55. Plug
56. Nut (4)
57. Bolt (2)
58. Lock washer (6)
59. Filler assembly
60. Gasket
61. Bolt (23)
62. Lock washer (23)
63. Cover assembly
64. Gasket
65. Plug
66. Seal (18)
67. Liner (6)
68. Seal
69. Block assembly
70. Nut (14)
71. Stud (14)
72. Cap
73. Cap (6)
74. Plug (2)
75. Plug
76. Plug (3)
77. Stud (6)
78. Orifice (6)
79. Ball
80. Pin (2)
81. Plug
82. Tube
83. Plug
84. Plug
84A. Ball
85. Shaft assembly
85A. Shaft
85B. Ball
86. Pin (2)
87. Pin
88. Pin
89. Pin (6)
90. Plug
91. Plug
92. Pin
93. Pin
94. Plug
95. Pin
96. Plug
97. Plug (2)
98. Plug
98A. Plug
98B. Plug
98C. Bearing sleeve
99. Block

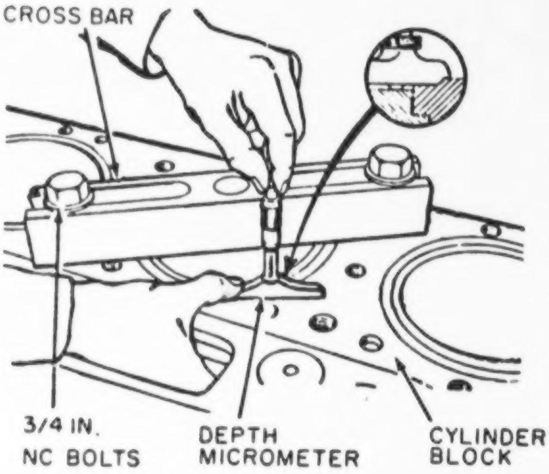

Figure 8-57. Securing cylinder liner in its bore and measuring height projection

f. Install camshaft drive group (paragraph 8-211).

g. Install camshaft group and related parts (paragraph 8-203).

h. Install oil pump group (paragraph 8-179).

i. Install oil pan group and related parts (paragraph 8-171).

j. Install aftercooler group (paragraph 8-163).

k. Install exhaust manifold group (paragraph 8-155).

l. Install accessory drive group (paragraph 8-149).

m. Install fuel injection group (paragraph 8-140).

n. Install utility governor group (paragraph 8-132).

o. Install governor actuator unit (paragraph 8-116).

p. Install hydraulic pump drive group (paragraph 8-107).

q. Install hydraulic pump (precise sets only) (paragraph 8-99).

r. Install hydraulic tank (precise sets only) (paragraph 8-92).

s. Install oil cooler group (paragraph 8-84).

t. Install fuel pump group (paragraph 8-68).

u. Install tachometer drive group (paragraph 8-60).

v. Install fan mounting group (paragraph 8-37).

w. Refer to Operator and Organizational Maintenance Manual and install the following:

1. Water pump group.
2. Alternator assembly.
3. Starter motor assembly.
4. Turbocharger group.
5. Day tank assembly.
6. Manual throttle control.
7. Lube oil filter group.
8. Ether atomizer.
9. Air cleaner assembly.
10. Engine wiring harness.

## Section XXXI. ENGINE TEST AFTER OVERHAUL

### 8-236. GENERAL.

Following a complete overhaul or any major repair, involving the installation of piston rings, pistons, cylinder liners, or bearings, the engine should be run-in prior to release for service.

NOTE

Make sure all necessary adjustments have been performed and engine is fully serviced before starting test.

### 8-237. ENGINE ASSEMBLY RUN-IN AND ADJUSTMENTS.

Connect engine assembly to a suitable engine dynamometer equipped with a cooling system and means of monitoring engine oil pressure, coolant temperature, and engine RPM.

a. PRE-RUN-IN CHECKS.

NOTE

Rotate engine in a clockwise direction only, when viewing engine from front.

1. To manually rotate the engine, remove the cover plate and four screws and washers of the accessory drive housing. Place a 1-1/8 inch (28.575 mm) box wrench on the hexagon shaft and rotate either clockwise or counterclockwise as required.

2. Hold manual fuel shutdown lever in the closed rack or off position (figure 8-58).

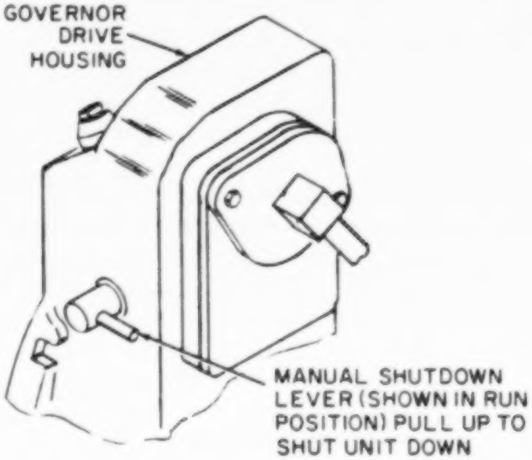
GOVERNOR DRIVE HOUSING
MANUAL SHUTDOWN LEVER (SHOWN IN RUN POSITION) PULL UP TO SHUT UNIT DOWN

Figure 8-58. Location of manual fuel shutdown lever

CAUTION

Do not crank starter motor for a period of more than 15 seconds.

3. Turn engine over using starter until oil pressure builds up to 50 ± 10 PSIG (3.515 ± .073 kg/sq cm). Oil pressure should build up within 15 seconds.

4. Release manual fuel shutdown lever. Inspect all fluid systems for signs of leakage.

b. UTILITY GOVERNOR SPEED SETTING ADJUSTMENT. Adjust utility governor low and high speed stops as follows:

1. Loosen nut (5, figure 8-28) and turn low speed stop screw (4) counterclockwise until it is free of speeder spring (46).

CAUTION

Do not crank engine for more than 15 seconds at a time. Permit starter to cool a minimum of three minutes between crankings.

2. Crank engine over with starter and turn low speed stop screw (4) clockwise until governor output shaft (13, figure 8-28) rotates, opening fuel rack. Continue turning low speed stop screw until engine starts.

3. Permit engine to run a minimum of five minutes for warmup and adjust low speed stop screw (4) to obtain 800 RPM idle speed. Clockwise rotation will increase speed. Hold screw in position and tighten nut (5). Recheck RPM setting.

4. Rotate speed adjusting shaft (25) to maximum speed position and monitor engine RPM. Do not exceed 2300 RPM.

5. Engine high speed stop setting should be 2250 RPM. To adjust high speed stop, loosen nut (20) and rotate high speed stop screw (19) to obtain 2250 RPM when speed adjusting shaft (25) is in maximum speed position. Clockwise rotation will increase engine RPM setting. Tighten lock nut and re-check RPM setting.

6. If engine surges during warmup, remove governor cover (6) while engine is running and move droop bracket (11) and pin (22) towards maximum position (away from governor ball head assembly (57).

7. When the engine is warmed up, adjust the droop bracket (11) and pin (22) as much towards minimum (toward ball head assembly (57) as possible while maintaining steady speed. Manually move the engine fuel linkage to cause a temporary engine speed increase. If the engine returns to the original steady speed, the adjustment is satisfactory. If the engine speed does not settle out, increase droop slightly (approximately 1/16 of an inch (1.588 mm) movement of bracket (11) and test again. Continue to increase the droop until the operation is satisfactory.

NOTE

The factory droop setting NL to FL is 3%, 1.8 HZ.

c. RUN-IN. During run-in, monitor oil pressure and coolant temperature and check for unusual noise and vibrations. Discontinue run-in if oil pressure drops below 20 psi, (1.406 kg/sq cm) if coolant temperature exceeds 217°F, (103°C) or if unusual noise and vibrations occur.

1. Start engine and operate at idle speed (approximately 800 RPM), no load for 10 minutes.

NOTE

Three-quarter speeds are 1125 RPM for 50 hertz operation, 1350 RPM for 60 hertz operation.

2. Operate engine at 3/4 rated speed and at 100 KW for fifteen minutes.

NOTE

Rated speeds are 1500 RPM for 50 hertz operation, 1800 RPM for 60 hertz operation.

3. Operate engine at rated speed and at 200 KW for 30 minutes.

NOTE

Required tightness for cylinder head bolts after test to be 330 foot-pounds (45.639 kg - meters) minimum

4. Shut down engine and retighten all bolts and nuts. Tighten cylinder head bolts, refer to figure 8-46.

5. Inspect engine for leakage.

# CHAPTER 9

# BASE ASSEMBLY, STOWAGE TOOL BOX, AND FUEL TANK REPAIR INSTRUCTIONS

## Section I. BASE ASSEMBLY

### 9-1. GENERAL.

The base is a welded structure that supports the generator set and the fuel tank. It consists of tubular cross members, forklift openings, and ground stud. The engine and generator are mounted to the base, the engine front support and generator mounting provide a three point support system for the engine and generator. A battery and rollout tray assembly is mounted in the front end of the base. Each end of the base is equipped with a tubular cross member which permits connection of a towing device for skidding the generator set, for short distance moving. Openings are provided in the base to permit the generator set to be lifted by a forklift. The base is equipped with a split-stud terminal to permit electrical grounding of the set.

### 9-2. REMOVAL.

Remove the following assemblies from the base assembly:

a. Refer to Operator and Organizational Maintenance Manual and perform the following:

1. Drain coolant from the radiator.

2. Drain fuel from the day tank and fuel tank.

3. Drain lubricating oil from engine crankcase.

4. Remove batteries and rollout tray.

b. Remove housing as specified in paragraph 3-2.

c. Remove generator as specified in paragraph 2-7.

d. Remove engine as specified in paragraph 2-8.

### 9-3. DISASSEMBLY.

Refer to figure 9-1 and disassemble base assembly in the order of index numbers assigned. Pay particular attention to the following:

a. Tag hoses (1, 2, 3, and 4) with location prior to removal.

b. Remove fuel tank (28) through rear opening. Disassemble fuel tank (28) as specified in paragraph 9-19.

### 9-4. CLEANING.

a. Clean parts with an approved cleaning solvent and dry thoroughly. If necessary, remove hand deposits using a bristle brush.

b. Clean sealant from pipe threads using a wire brush.

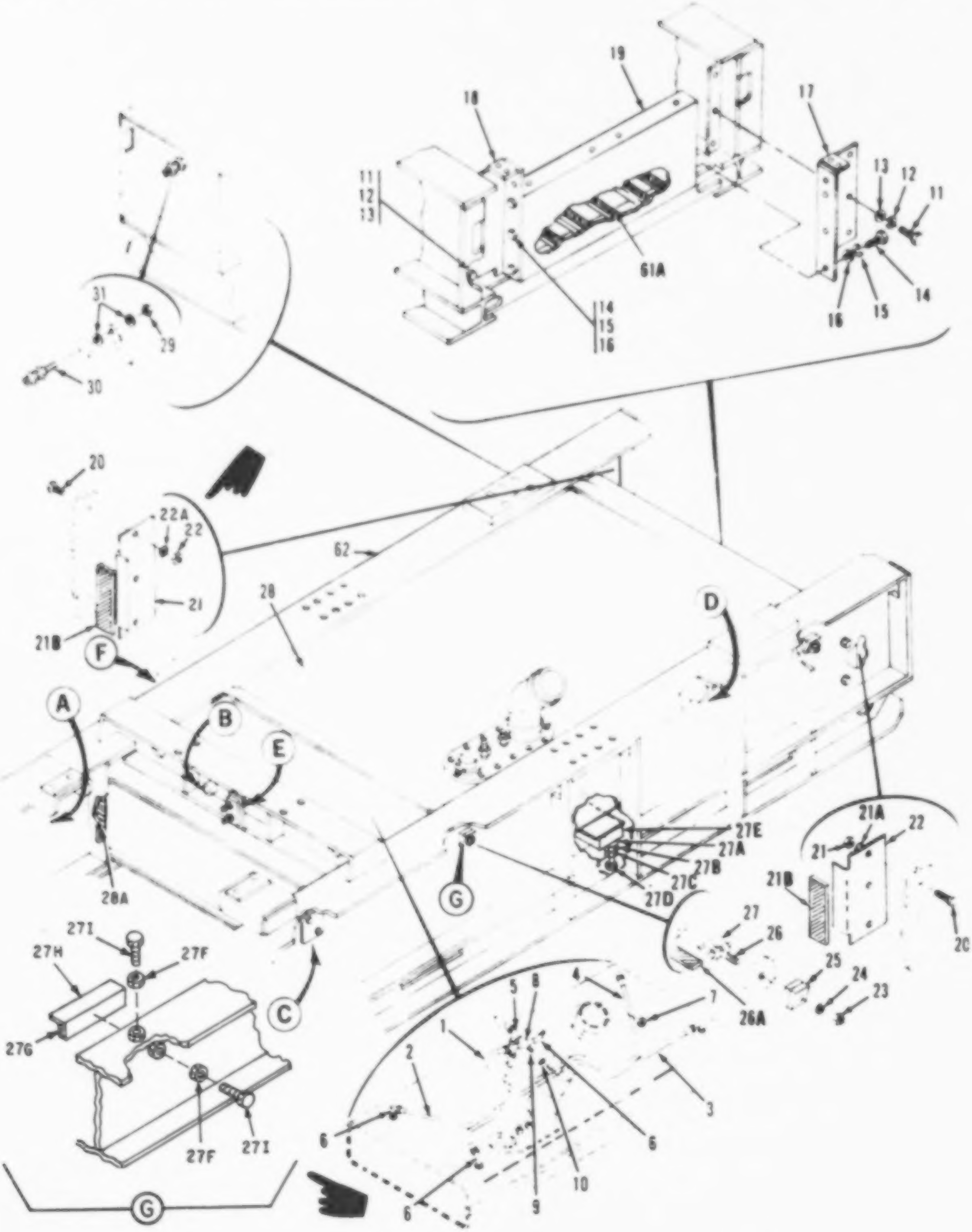
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Figure 9-1. Base assembly, exploded view (sheet 1 of 2)

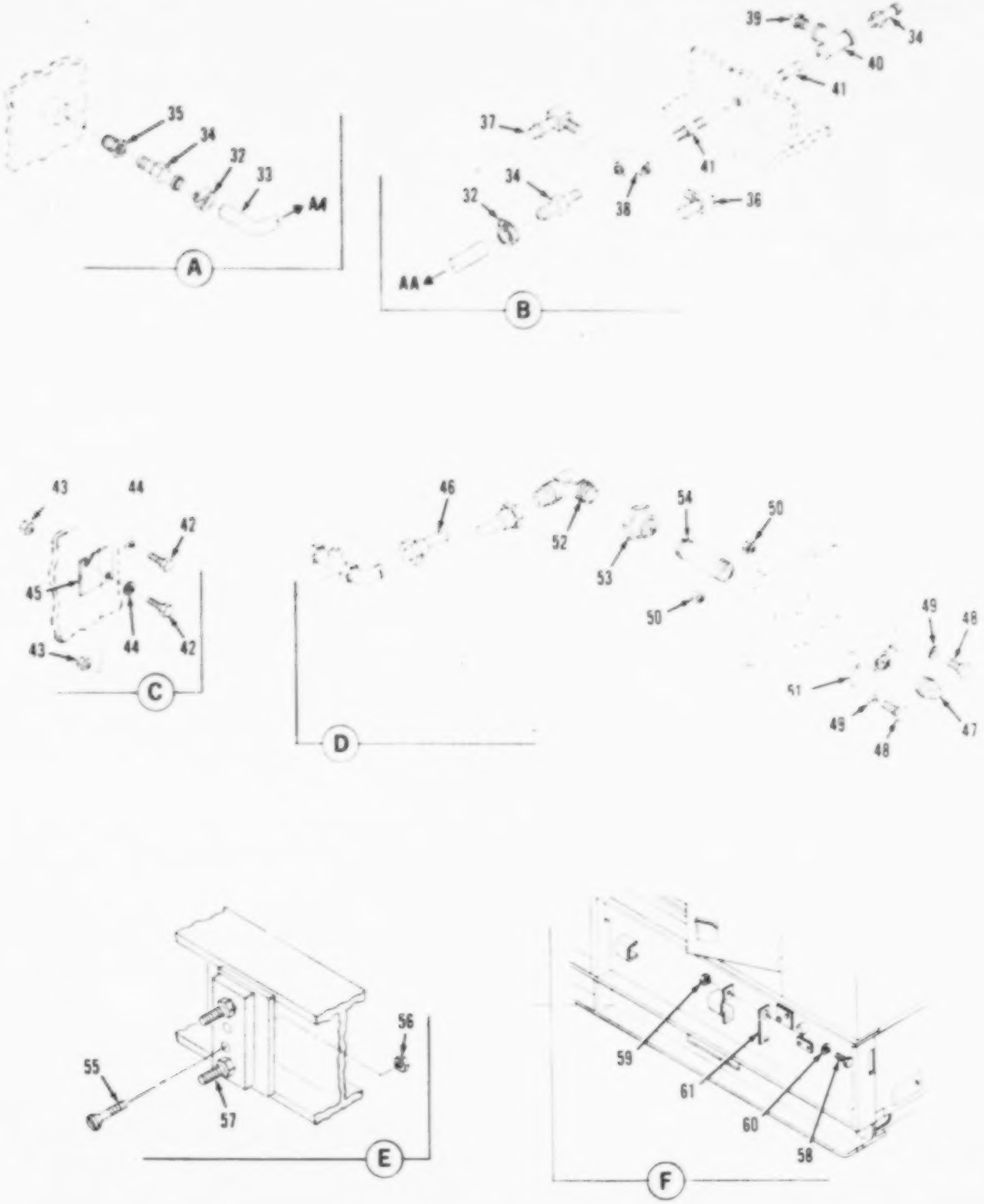
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Figure 9-1, Base assembly, exploded view (sheet 2 of 2)

Legend to figure 9-1:

1. Hose assembly
2. Hose assembly
3. Hose assembly
4. Hose assembly
5. Tee (2)
6. Elbow (5)
7. Nut
8. Cross
9. Connector
10. Washer
11. Screw (6)
12. Lock washer (6)
13. Washer (6)
14. Screw (6)
15. Lock washer (6)
16. Washer (6)
17. Filler panel
18. Filler panel
19. Lower rear panel
20. Screw (6)
21. Nut (6)
21A. Washer (6)
21B. Rubber strip (2)
22. Fuel tank retainer (2)
22A. Washer
23. Nut (4)
24. Lock washer (4)
25. Bevel washer (8)
26. Tee bolt (4)
26A. Rubber strip (2)
27. Retaining strap (2)
27A. Washer (2)
27B. Nut (2)
27C. Nut (2)
27D. Screw (2)
27E. Support channel
27F. Nut
27G. Webbing
27H. Angle
27I. Bolt
28. Fuel tank assembly
28A. Rubber strip (3)
29. Nut
30. Ground terminal
31. Lock washer (2)
32. Clamp (2)
33. Hose
34. Connector (3)
35. Reducer bushing
36. Elbow
37. Elbow
38. Cross
39. Plug
40. Tee
41. Nipple (2)
42. Screw (2)
43. Nut (2)
44. Washer (2)
45. Heater cover plate
46. Oil drain hose assembly
47. Plug
48. Screw (2)
49. Washer (2)
50. Nut (2)
51. Coupling assembly
52. Elbow
53. Adapter
54. Nipple
55. Screw (2)
56. Nut (2)
57. Fuse holder
58. Screw (2)
59. Nut (2)
60. Washer (2)
61. Rod stop ground plate
61A. Support strips (5)
62. Base

## 9-5. INSPECTION.

a. Inspect parts for cracks, breaks, and defective welds.

### CAUTION

If hose blockage is due to deterioration of internal portion of hose, hose shall be replaced.

b. Check hose for blockage, chafing, and condition of end fittings.

c. Inspect bevel washer for deterioration, cracks, and permanent set in washer contact surface.

d. Inspect threads for damage.

e. Inspect components for distortion.

f. Inspect paint for damage.

## 9-6. REPAIR.

a. Weld cracks, breaks, and defective welds.

b. Repair damaged threads by chasing using a suitable die or tap.

c. Straighten distorted components using suitable tools.

d. Remove damaged paint with a suitable scraper. Blend in edges, prime, and paint damaged areas.

## 9-7. REASSEMBLY.

Refer to figure 9-1 and reassemble base assembly in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Reassemble fuel tank as specified in paragraph 9-23.

b. Apply thread sealing compound conforming to Military Specification MIL-S-45180, type III, to pipe threads prior to installation.

c. Install fuel tank (28) in base (62) through rear opening, making sure that fuel tank needle valves are toward opening. Push tank against front stops, hold tank in position, and install fuel tank retainers (22) so that retainers hold tank in position.

d. Install bevel washers (25) with thick ends on top.

## 9-8. INSTALLATION.

Install the following assemblies on the base assembly.

a. Install engine as specified in paragraph 2-8.

b. Install generator as specified in paragraph 2-7.

c. Install housing as specified in paragraph 3-6.

d. Refer to Operator and Organizational Maintenance Manual and perform the following:

1. Install batteries and rollout tray.

2. Service engine crankcase, fuel tank, and radiator.

## Section II. STOWAGE TOOL BOX

## 9-9. GENERAL.

The stowage tool box is utilized for storage of tools and miscellaneous equipment required for generator set operation. The box consists of a hinged cover and box.

## 9-10. REMOVAL.

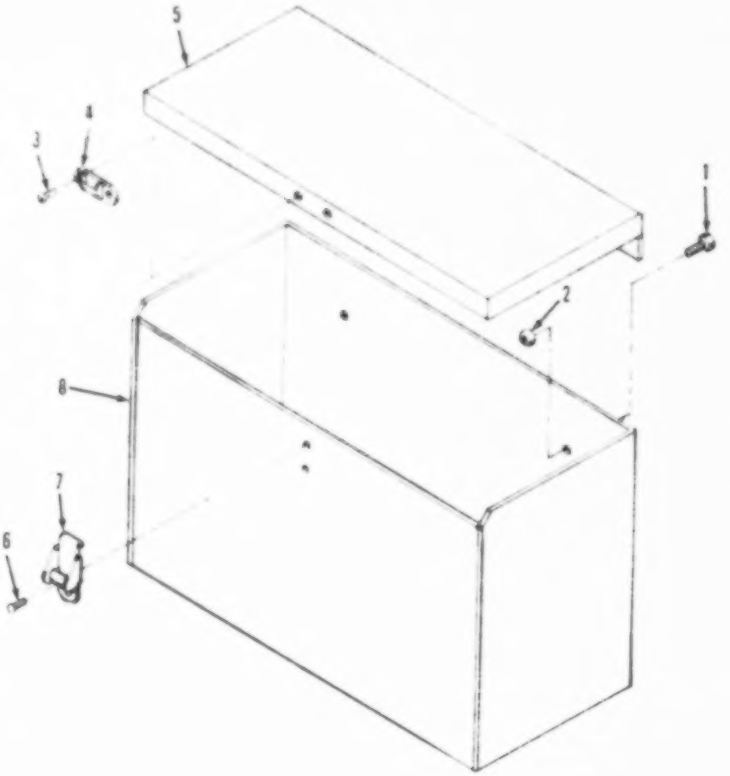
Remove stowage tool box from left side of generator skid base by removing three nuts, washers, and screws.

## 9-11. DISASSEMBLY.

Refer to figure 9-2 and disassemble the stowage tool box in the order of index numbers assigned.

## 9-12. CLEANING.

a. Clean metal parts in an approved cleaning solvent and dry thoroughly.



1. SCREW ASSEMBLY (5)
2. NUT ASSEMBLY (5)
3. RIVET (2)
4. KEEPER
5. COVER
6. RIVET (2)
7. FASTENER
8. STOWAGE BOX

Figure 9-2. Tool stowage box assembly, exploded view

### 9-13. INSPECTION.

a. Inspect sheet metal parts for cracks, dents, distortion, and worn hinges.

b. Inspect paint for damage.

### 9-14. REPAIR.

a. Straighten dented and distorted parts using suitable tools.

b. Weld cracks.

c. Remove damaged paint with a suitable scraper. Blend in edges, prime, and paint.

### 9-15. REASSEMBLY.

Refer to figure 9-2 and reassemble the stowage tool box in the reverse order of the numbers assigned.

### 9-16. INSTALLATION.

Install stowage tool box on left side of generator skid base and secure with screws, washers, and nuts.

## Section III. FUEL TANK ASSEMBLY

### 9-17. GENERAL.

The baffled fuel tank stores fuel for generator set operation and is located within the base assembly. The fuel tank assembly consists of a fuel level transmitter, plate assembly, and two needle valves. The fuel level transmitter senses the fuel level in the fuel tank and transmits a signal to the fuel gauge on the control cubical, which indicates a reading corresponding to that of the fuel level transmitter. The needle valves permit draining of the fuel tank and removal of water and sediment from the tank.

### 9-18. REMOVAL.

Refer to figure 9-1 and remove the fuel tank as follows:

a. Refer to Operator and Organizational Maintenance Manual and drain fuel tank.

b. Disconnect generator set air intake doors, below control cubicle by removing fourteen screws, washers, and nuts.

c. Disconnect generator set air inlet louver and screen assembly by removing twenty screws, forty washers, and sixteen nuts.

d. Remove panels (17, 18, and 19) as an assembly from base (62) by removing eight screws, lock washers, and washers.

e. Remove fuel tank retainers (22) from base.

f. Disconnect ground lead from base by removing nut (29), load terminal (30), and lock washers (31).

g. Pull oil drain coupling assembly (51) away from skid base (62) by removing screws (48), nuts (50), and washers (49) to insure no interference of oil drain hose (46) when removing fuel tank.

h. Loosen clamp and remove fuel filler hose from fuel tank.

i. Disconnect electrical connector from fuel tank fuel level transmitter.

j. Tag and disconnect fuel and vent lines from fuel tank and plug lines.

k. Remove fuel tank retaining straps (27).

l. Remove the fuel tank (28) from the base through rear opening.

### 9-19. DISASSEMBLY.

Refer to figure 9-3 and disassemble fuel tank assembly in the order of index numbers assigned. Pay particular attention to the following:

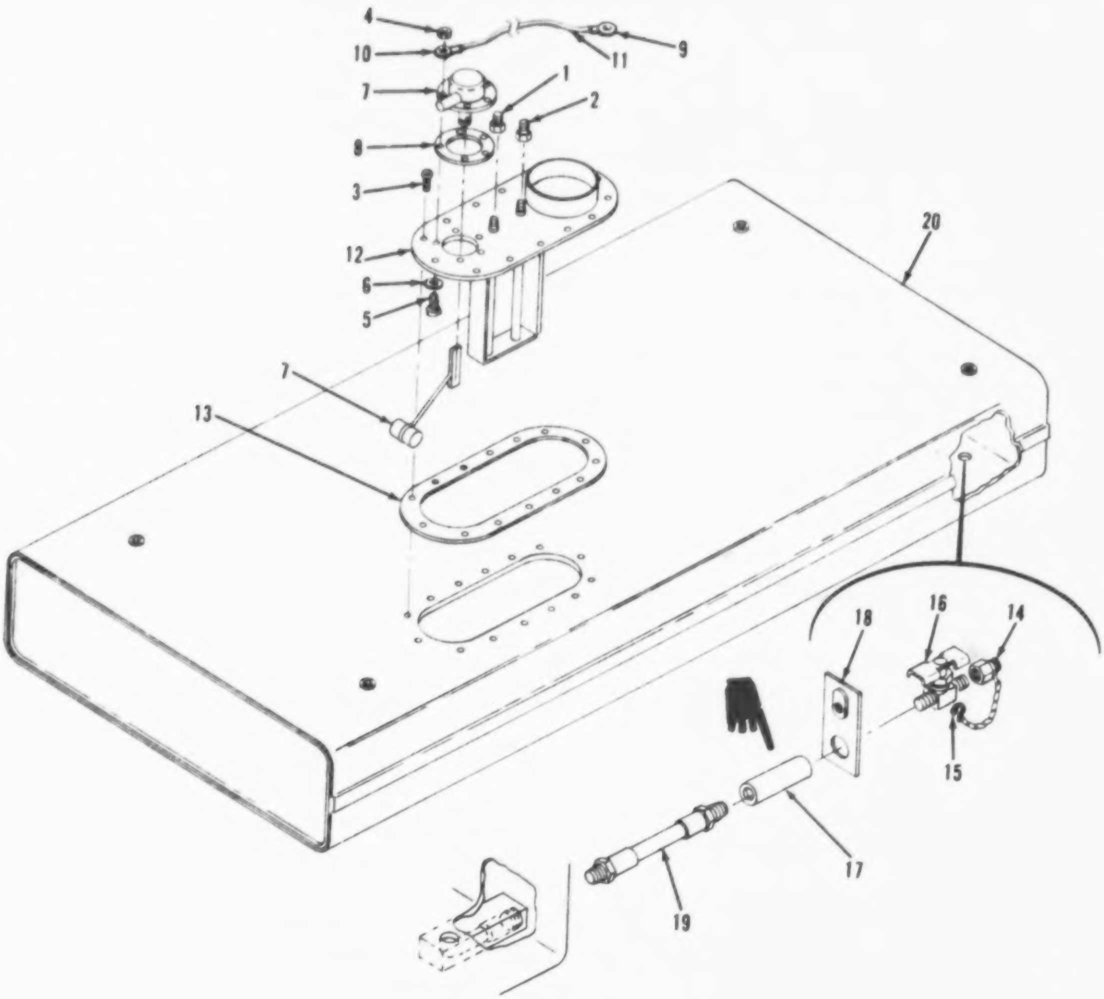
a. Mark alignment marks on plate (12) and fuel tank (20) to insure proper reassembly.

### 9-20. CLEANING.

a. Remove old gaskets (8 and 13) using a suitable scraper.

b. Clean parts and exterior of fuel tank with an approved cleaning solvent and dry thoroughly.

c. Clean interior of fuel tank with clean fuel oil. Agitate fuel tank to loosen


4
10
11
9
7
1
2
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12
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1. Connector
2. Connector
3. Screw (14)
4. Nut (5)
5. Screw (5)
6. Packing (5)
7. Fuel Level transmitter
8. Gasket
9. Lug
10. Lug
11. Wire
12. Plate
13. Gasket
14. Cap (2)
15. Hook (2)
16. Needle valve (2)
17. Bulkhead fitting (2)
18. Drain support plate (2)
19. Hose assembly (2)
20. Fuel tank

Figure 9-3. Fuel tank assembly, exploded view

sediment and pour fuel from tank. Repeat procedure until all sediment is removed from tank.

d. If sediment can not be removed by performing step c. or fuel tank is to be repaired by welding, steam clean tank to remove sediment or to purge tank of fuel vapors.

e. Clean old sealant from pipe threads using a wire brush.

## 9-21. INSPECTION.

a. Shake transmitter float to check for fuel in float which would indicate a crack or hole in float.

b. Using a multimeter, perform resistance test on fuel level transmitter. Resistance shall be 0.00 to 0.50 ohms at empty (down) position, and 29.50 to 31.50 ohms at full (up) position.

c. Connect transmitter float to fuel level transmitter and check float movement. At full (up), float shall be 0.47 to 0.53 inch (11.93 to 13.46 mm) from bottom of fuel level transmitter flange. At empty (down), the float shall be 11.69 to 11.94 inches (296.926 to 303.276 mm) from bottom of fuel level transmitter flange.

d. Check fuel tank for leaks as follows:

1. Plug all fuel tank openings except one. Connect a suitable low pressure regulated air supply to remaining fuel tank opening.

2. Slowly apply 0.5 PSI (.0352 kg/sq cm) air pressure to fuel tank.

3. Apply a soapy water solution to fuel tank and check for bubbles that would indicate leaks. Mark leaks, if any.

4. Reduce air pressure to zero. Remove test equipment for tank. Remove soapy water solution from fuel tank.

e. Connect a suitable pressure supply and gage to needle valve. Turn on pressure supply and bleed test equipment by opening valve. Close valve. Slowly apply 150 PSI (10.546 kg sq/cm) and check for external and internal leakage. Reduce pressure to zero and remove test equipment from valve.

f. Check transmitter float linkage for distortion.

g. Inspect for damaged threads.

h. Inspect paint for damage.

## 9-22. REPAIR.

### WARNING

Do not weld fuel tank unless tank has been steam cleaned and it is filled with water.

a. Repair cracks and holes in fuel tank as follows:

1. Steam clean tank to remove fuel vapors.

2. Fill tank with water.

3. Weld cracks or holes. Large damaged area may be repaired by welding a suitable patch over area.

4. Remove water from fuel tank and dry interior of tank thoroughly.

5. Check repaired areas for leakage as specified in paragraph 9-21, step d.

b. Straighten distorted transmitter float linkage using suitable tools.

c. Repair damaged fuel tank threads using a suitable tap. Fill tap grooves with grease to catch cuttings. Remove all cuttings from fuel tank.

d. Remove damaged paint with a suitable scraper. Blend in edges, prime, and paint damaged areas.

## 9-23. REASSEMBLY.

Refer to figure 9-3 and reassemble fuel tank assembly in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Apply thread sealing compound conforming to Military Specification MIL-S-45180, type III, to pipe threads prior to reassembly.

b. Make sure alignment marks on fuel tank (20) and plate (12) are aligned when plate is installed.

## 9-24. INSTALLATION.

Refer to figure 9-1 and install the fuel tank as follows:

a. Install fuel tank (28) in base (62) through rear opening, making sure needle valves are toward opening. Position and hold tank against forward stops and install fuel tank retainers (22).

b. Install panels (17, 18, and 19) as an assembly on base (62) with eight screws, lock washers, and washers.

c. Install oil drain coupling assembly (51) on base (62) with screws (48), nuts (50), and washers (49).

d. Connect ground lead to base with load terminal (30), lock washers (31), and nut (29).

e. Install and secure fuel tank retaining straps (27), making sure that thick end of bevel washers (25) are on top.

f. Connect fuel and vent lines to fuel tank. Connect electrical connector to fuel level transmitter.

g. Connect fuel filler hose to fuel tank and secure with clamp.

h. Install generator set air inlet louver and screen assembly, and secure with screws, washers, and nuts.

i. Install generator set air intake doors and secure with screws, washers, and nuts.

j. Refer to Operator and Organizational Maintenance Manual and service fuel tank.

# CHAPTER 10

# TEST AFTER OVERHAUL

## Section I. PRETEST CHECKS AND ADJUSTMENTS

### 10-1. GENERAL.

Pretest checks and adjustments shall be performed prior to test after overhaul of the generator set. To perform the pretest checks and adjustments, proceed as follows:

### 10-2. PRETEST CHECKS AND ADJUSTMENTS.

a. Perform engine assembly run-in and adjustments paragraph 8-238.

b. Perform alignment of electric governor actuator unit (precise generator sets only), refer to paragraph 6-223.

## Section II. TEST AFTER OVERHAUL

### 10-3. GENERAL.

All tests should be performed under the following conditions:

a. All tests shall be made at ambient temperatures.

b. All test instrumentation will be in accordance with Military Standardization Handbook MIL-HDBK-705 and Military Standard MIL-STD-705, as applicable.

c. Temperatures will be measured by means of appropriately located thermocouples and properly calibrated read-out devices. Thermocouples will be insulated from contact with other metals. Temperatures will be recorded in degrees Farenheit or Centigrade, depending on the instrument scale, but will be reduced in degrees Farenheit in all cases. Barometric pressure will be measured by a mercurial barometer, which will be corrected for the temperature of the scale, the mercury for vapor pressure and for the location of the barometer with regard to altitude and latitude. Aneroid barometers will not be used.

d. Pretest adjustments shall be completed prior to starting test procedures, refer to paragraph 10-2.

e. Operational procedures required in support of the individual test specified herein shall be performed as outlined in the Operator and Organizational Maintenance Manual.

f. Record test results as required by local instructions.

### 10-4. START AND STOP TEST.

Test the generator set for evidence of abnormal start and stop conditions by performing the start and shutdown procedures as outlined in the Operator and Organizational Maintenance Manual. The generator set should be capable of starting promptly at any ambient temperatures in the range of +125°F to -25°F (51.7 to -31.7°C) without external heat.

a. Operate generator set at rated speed, voltage, and no-load for 15 minutes, then shutdown generator set.

b. Operate generator set at rated speed, voltage, and no-load for 15 minutes. Discontinue operation by de-energizing the DC circuit breaker.

c. Repeat start-stop procedures two additional times. If any malfunction is noted, make necessary repairs before subjecting the generator set to the remaining tests.

## 10-5. INSTRUMENT CHECK.

Test the generator set ammeter, voltmeter, and frequency meter for accuracy by comparing them with master instruments.

a. Adjust the meters to zero as outlined in the Operator and Organizational Maintenance Manual.

NOTE

This test shall be repeated at all rated frequencies and at voltages of 120/208 and 240/416.

b. Connect the generator set to a variable load. Operate the generator set and vary the load as indicated in step c.

c. Record the master instrument reading and the readings of the meters at the following percentages of rated load: 1/4, 2/4, 3/4, 4/4, and 5/4 percent.

d. The accuracy of the instruments should be such that the maximum error will not exceed the following parameters:

1. Voltmeter - 2-1/2 percent of full scale except not greater than 5 volts between 115 and 125 volts, not greater than 10 volts between 200 and 250 volts.

2. Ammeter - 2 percent of full scale.

3. Kilowatt meter - 2 percent of full scale.

4. Frequency meter - 0.25 percent at any point on scale.

## 10-6. LOW OIL PRESSURE TRIP TEST.

Perform this test under an artificially produced condition as follows:

a. Install a test adapter with a gage for measuring pressure to the lubricating oil pressure switch, a valve for shutting off flow to pressure switch, and a valve for bleeding off pressure. Operate the generator set at rated speed and no load.

b. Purge air from system through the bleed valve. Close valve and record operating pressure.

CAUTION

If unit fails to shut down when oil pressure is between 12 and 18 (0.8437 and 1.2655 kg sq/cm) PSI, the test should be discontinued and corrective action taken.

c. Close pressure shutoff valve and slowly bleed pressure from system until the generator set shuts down and LOW OIL PRESSURE fault locator indicator illuminates. Record pressure. The generator set shutdown and LOW OIL PRESSURE fault locator indicator shall occur simultaneously at 15 ± 3 PSI.

d. Remove test components from generator set.

## 10-7. HIGH COOLANT TEMPERATURE TRIP TEST.

Perform the high coolant temperature trip test as follows:

a. Remove coolant temperature transmitter from front of engine thermostat housing and install thermocouple in its place.

### CAUTION

If the engine fails to shut down when 222°F is reached, drop the load and unblock the radiator to cool engine.

b. Operate unit at rated speed, block air passing through the radiator and apply sufficient load to raise the unit temperature to the trip point of 217 ± 3°F. The high coolant temperature switch shall actuate at 214° to 220°F, causing the circuit breaker (CB2) to open, the engine to shut down, and the COOLANT HIGH TEMP fault indicator to illuminate.

c. Remove thermocouple and replace coolant temperature transmitter.

## 10-8. LOW FUEL LEVEL TRIP TEST.

Perform the low level trip test as follows:

a. Energize DC circuit breaker and position start-run-stop switch to RUN to fill day tank. When day tank is full, the electric fuel transfer pumps will change pitch indicating they are bypassing fuel internally.

b. Disconnect electrical connector from day tank fuel solenoid valve.

c. Operate the generator set at rated voltage, frequency and at full load until day tank float valve switch actuates, causing the circuit breaker (CB2) to open, the engine to shut down and the NO FUEL fault indicator to illuminate.

d. Start generator set and as soon as engine starts, lift red battle short switch guard and position switch to ON. Operate generator set for one minute at rated voltage, frequency and fuel load. Generator set should operate for one minute without running out of fuel. Shut down generator set, but do not de-energize DC circuit breaker.

e. Connect electrical connector to day tank fuel solenoid valve. Position start-run-stop to RUN and fill day tank. Position battle short switch and guard to OFF position and de-energize DC circuit breaker.

## 10-9. SHORT CIRCUIT TRIP TEST.

Perform the short circuit trip test as follows:

a. Connect a load bank capable of supplying 450 percent of rated current to the generator set load terminals. Reactive load may be used to obtain the required current.

b. Adjust short circuit load to draw 350 percent of rated current.

c. Operate the generator set at rated voltage, rated speed, and rated load.

d. Apply short circuit load of 350 percent rated current (total of 450 percent of rated current) to the generator set in one step.

CAUTION

If output contactor fails to open, instantaneously remove short circuit.

e. The circuit breaker (CB2) shall actuate instantaneously when current exceeds 425 ± 25 percent of rated current, causing the SHORT CIRCUIT fault indicator to illuminate.

### 10-10. OVER AND UNDER VOLTAGE TRIP TEST.

Perform the over and under voltage trip tests as follows:

a. Connect a voltmeter between T9 and T12 of the monitored 120 volt phase.

b. Operate the generator set at no load, rated frequency, and rated voltage with circuit breaker (CB2) closed.

c. OVER VOLTAGE TRIP TEST. Raise voltage until the engine shuts down and OVER VOLT fault locator indicator illuminates. Record the voltage. The over voltage relay shall actuate when the voltage exceeds 153 ± 3 volts for more than 200 milliseconds causing the circuit breaker (CB2) to open within 1 second, the engine to shut down and the OVER VOLT fault indicator to illuminate.

d. UNDER VOLTAGE TRIP TEST (PRECISE GENERATOR SETS ONLY).

1. Repeat step b., lower voltage until the UNDER VOLT fault locator indicator illuminates. Record voltage. Circuit breaker (CB2) shall open immediately when voltage drops below 48 volts, causing the UNDER VOLT fault locator indicator to illuminate.

2. Repeat step b., reduce voltage between 65 to 103 volts. Circuit breaker (CB2) shall open in 6 ± 2 seconds, causing the UNDER VOLT fault locator to illuminate.

3. Repeat steps b., 4.1., and 4.2. two additional times.

### 10-11. UNDER FREQUENCY TRIP TEST (PRECISE GENERATOR SETS ONLY).

Perform the under frequency trip test as follows:

a. Operate the generator set at no load, rated frequency, and rated voltage with circuit breaker (CB2) closed.

b. Lower frequency until the UNDER FREQ fault locator indicator illuminates. Circuit breaker (CB2) should open, causing the UNDER FREQ fault locator indicator to illuminate when the frequency drops to the values indicated below:

50 hertz operation - 46 ± 1 hertz

60 hertz operation - 55 ± 1 hertz

### 10-12. PHASE SEQUENCE CHECK.

Perform the phase sequence check as follows:

a. Connect a suitable phase sequence indicator to generator set load terminals.

b. Operate generator set and determine phase sequence by observing the indicator. The AC output connections shall be of the proper rotation, compare test results with the AC system simplified schematic, figure 1-3.

c. If generator set is equipped with an AC output receptacle box, check phase sequence of each receptacle for proper rotation.

## 10-13. PHASE BALANCE TEST.

Perform the phase balance test as follows:

a. Operate generator set at 240/416 volts, rated speed and no load. Adjust voltage as necessary until average voltage is 240 volts line to neutral. Measure each line to neutral voltage to the nearest 0.1 volt at load terminals and record.

NOTE

Load must be balanced. Record all three line to neutral voltages and obtain the average value. Reduce or raise voltage as required, by the amount that the previously computed average differs from rated voltage. The average of the three phase voltages should be equal to rated voltage.

b. Measure and record each of the line to neutral voltages.

c. The maximum difference in the three line-to-neutral voltage under all balanced loads at rated voltage and speed shall not exceed one percent rated voltage and speed shall not exceed one percent rated line-to-neutral voltage. That is, no phase voltage shall differ from the average by more than 1.2 volts.

d. Formula to compute percentage of voltage unbalance is as follows:

$$\frac{100 \times \text{maximum deviation from average}}{\dfrac{(T1-N) + (T2-N) + (T3-N)}{3}}$$

## 10-14. FREQUENCY ADJUSTMENT RANGE TEST.

Perform the frequency adjustment range test as follows:

a. PRECISE GENERATOR SETS.

1. Operate generator set at full load.

2. Slowly adjust frequency from 58 to 62 hertz. Clockwise rotation shall increase frequency. Voltage shall remain at rated value throughout the frequency range. The frequency rheostat shall allow frequency adjust over the following ranges at any load:

50 hertz operation - Between 48 and 52 hertz but not below 45 hertz.

60 hertz operation - Between 58 and 62 hertz but not above 65 hertz.

b. UTILITY GENERATOR SETS.

1. Operate generator set at full speed by adjusting manual speed control. Record frequency.

2. Turn manual speed control knob 90 degrees. Record frequency. A 90 degree turn of the manual speed control knob shall not cause a change in frequency greater than 1 percent.

3. Repeat step 2. a number of times, both raising and lowering frequency.

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4. Rapidly decrease engine speed by turning the manual speed control knob to its lowest possible speed obtainable. Increase engine speed by turning the manual speed control knob to its maximum speed obtainable. The manual speed control shall be adjustable from idle (approximately 1400 RPM) to 2250 + 25 RPM.

## 10-15. REGULATOR RANGE TEST.

Perform the regulator range test as follows:

a. Operate generator set at 240/416 volts at full load. Adjust voltage for 480 volts. Record voltage and speed. Adjust voltage for 395 volts. Record voltage and speed.

b. Reduce load to zero. Adjust voltage for maximum attainable voltage. Record voltage and speed. Adjust voltage for minimum voltage attainable. Record voltage and speed.

c. The generator set shall operate at any load between no load and full load at the following line-to-line voltages:

1. Between 380 and 426 volts for 50 hertz operation.

2. Between 375 and 489 volts for 60 hertz operation.

## 10-16. EXCITER REGULATOR AND GOVERNOR STABILITY AND TRANSIENT RESPONSE TEST.

Perform the exciter regulator and governor stability and transient response test as follows:

a. Operate generator set at 240/416 volts at full load until temperatures have stabilized.

b. Drop and apply the load a sufficient number of times to make sure that the voltage and frequency are within the prescribed band.

c. The governor shall be set at isochronous regulation for precise generator sets and at 2.9 to 3 percent for utility generator sets. Adjust voltage to rated value. No further adjustments shall be made during this test. The recorders in the test circuit are now started.

d. Perform the following load switching sequence starting with 50% load, waiting approximately 30 seconds between each load change:

Adjust load to 50% load and starting from no load: 50% load - 0 - 50% load - 0 - 50% load -0

Adjust load to 37.5% load and starting from no load: 37.5 - 0 - 37.5 - 0 - 37.5 - 0

Adjust load to 1/4 load and starting from no load:
25% - 0 - 25% - 0 - 25% - 0

Adjust load to 12.5% load and starting from no load: 12.5% - 0 - 12.5% - 0 - 12.5%

e. The frequency and voltage requirements are indicated below:

| Frequency | Precise | Utility |
|---|---|---|
| Steady State Band | 0.5 percent | 2 percent |
| Recovery Time | 2 seconds | 3 seconds |
| Overshoot and Undershoot | 4.0 percent | 4 percent and 3 percent |
| Regulation | 0.25 percent | 2 to 3 percent |

| Voltage | Precise | Utility |
|---|---|---|
| Steady State Band | 1.0 percent | 2 percent |
| Regulation | 1.0 percent | 3 percent |

## 10-17. LONG TERM STEADY STATE STABILITY TEST.

Perform the long term steady state stability test as follows:

a. Operate the generator set at rated speed, voltage, and full load for a period of four hours.

b. Record voltage and frequency at start and finish of the four hour period. The long term steady deviation at constant loads from no load to full load shall be as follows:

1. The bandwidth shall remain within 1 percent (for precise generator sets) and 3 percent (for utility sets) of the rated frequency.

2. The bandwidth shall remain within 2 percent (for precise generator sets) and 4 percent (for utility generator sets) of the rated voltage.

## 10-18. PARALLEL OPERATION AND REVERSE POWER TEST.

a. PARALLEL OPERATION. Perform the parallel operation test as follows:

1. Operate two or more generator sets in parallel at 240/416 volts at no load, refer to Operator and Organizational Maintenance Manual.

2. If necessary, make fine adjustments to governors and exciter regulator paralleling controls, with generator sets operating in parallel and at no load.

3. Precise generator sets shall divide load in accordance with the following as system load at rated power factor is varied between zero and 100 percent (and vice versa) of the combined rating of the connected sets:

(a) Real power division. - At no time shall the difference between the average individual kilowatt outputs of the three sets, when supplying the system load, be greater than ten percent of the kilowatt rating of one set.

(b) Power exchange. - At any constant system load up to the combined rating of the sets in parallel, power exchange between the sets shall not exceed 10 percent of the KW rating of one set. Power exchange is the difference between the maximum and minimum power output delivered by one set, for constant system load conditions.

(c) Reactive power division. - At no time shall the difference in average reactive KVA supplied by any three sets differ by more than ten percent of the reactive KVA rating of one set. For the above requirements, the initial system load shall be equally divided between the sets, both as to active and reactive components; thereafter, there shall be no adjustments to governors, voltage regulators, or any other component as system load is changed. When voltage regulators are not interconnected between sets, the above requirements shall apply also, except that voltage droop not exceeding three percent may be introduced through the voltage regulator reactive droop compensating circuits.

4. Utility generator sets shall divide load in accordance with the following system load at rated power factor is varied between 20 and 100 percent (and vice versa) of the combined rating of the connected sets:

(a) Real power division. - At no time shall the difference between the average individual kilowatt outputs of the three sets, when supplying the system load, be greater than ten percent of the kilowatt rating of one set.

(b) Power exchange. - At any constant system load up to the combined rating of the sets in parallel, power exchange between the sets shall not exceed 10 percent of the KW rating of one set. Power exchange is the difference between the the maximum and minimum power output delivered by one set, for constant system load conditions.

(c) Reactive power division. - At no time shall the difference in average reactive KVA supplied by any three sets differ by more than ten percent of the reactive KVA rating of one set. For the above requirements, the initial system load shall be equally divided between the sets, both as to active and reactive components; thereafter, there shall be no adjustments to governors, voltage regulators, or any other components as system load is changed.

b. REVERSE POWER TEST. Perform the reverse power test as follows:

1. Operate two generators sets in parallel at no load with load contactors closed, refer to Operator and Organizational Maintenance Manual.

2. Lower speed of generator set being tested until the REVERSE POWER fault locator indicator illuminates. Record value of kilowatt load at which the load contactor opens. The load contactor shall open when power flow into the generator sets exceeds 20 percent of rated value, causing the REVERSE POWER fault locator indicator to illuminate.

## 10-19. ENGINE EFFICIENCY TEST.

Perform the engine efficiency test as follows:

a. Operate the generator set at full rated load, speed, and voltage. Check the engine exhaust for excessive smoke and density of smoke.

b. The engine shall deliver 125 percent of rated load for five minutes. Engine exhaust smoke should be just visible at 100 percent load.

# CHAPTER 11

# FUEL BURNING WINTERIZATION KIT REPAIR INSTRUCTIONS

## Section I. CONTROL BOX

### 11-1. GENERAL.

There are two identical control boxes used in the fuel burning winterization kit (one per heater). They are located to the right of the control cubicle and each consists of an ON-OFF switch, a circuit breaker, press-to-test indicator light, and two receptacles for interconnection. The ON-OFF switch permits starting of the heater and a means of stopping the heater. When the switch is positioned to OFF, the heater motor will continue to operate for a period of approximately 4-1/2 minutes, to purge heated air and fuel from heater. The circuit breaker is a manual reset type; it protects the heater circuitry in case of an overload. The press-to-test indicator light illuminates to show that the heater is in operation, it is also a means of checking system electrical power.

### 11-2. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove the control boxes.

### 11-3. DISASSEMBLY.

Refer to figure 11-1 and disassemble control box in the order of index numbers assigned. Pay particular attention to the following:

CAUTION

**Prolonged use of soldering equipment could cause damage to components due to excessive heat.**

NOTE

Disassemble control box only to the extent necessary to effect repair.

a. Remove screws (1) and pull plate (2) aside. Tag and disconnect wiring from plate components.

b. Remove connectors (5 and 8). If necessary, remove wires from connectors.

c. Remove cover (10) from frame (26).

d. Remove lens (11), indicator light (15), circuit breaker (21), switch (25) and component board assembly (27).

### 11-4. CLEANING.

a. Clean electrical components with a cloth moistened with an approved cleaning solvent, and dry thoroughly.

b. Clean metal components with an approved cleaning solvent and dry thoroughly.

### 11-5. INSPECTION.

a. Inspect connectors and each wire for continuity. Refer to table 11-1. Inspect connectors for damaged threads; bent, loose, or missing pins; and for shorts to case and surrounding pins.

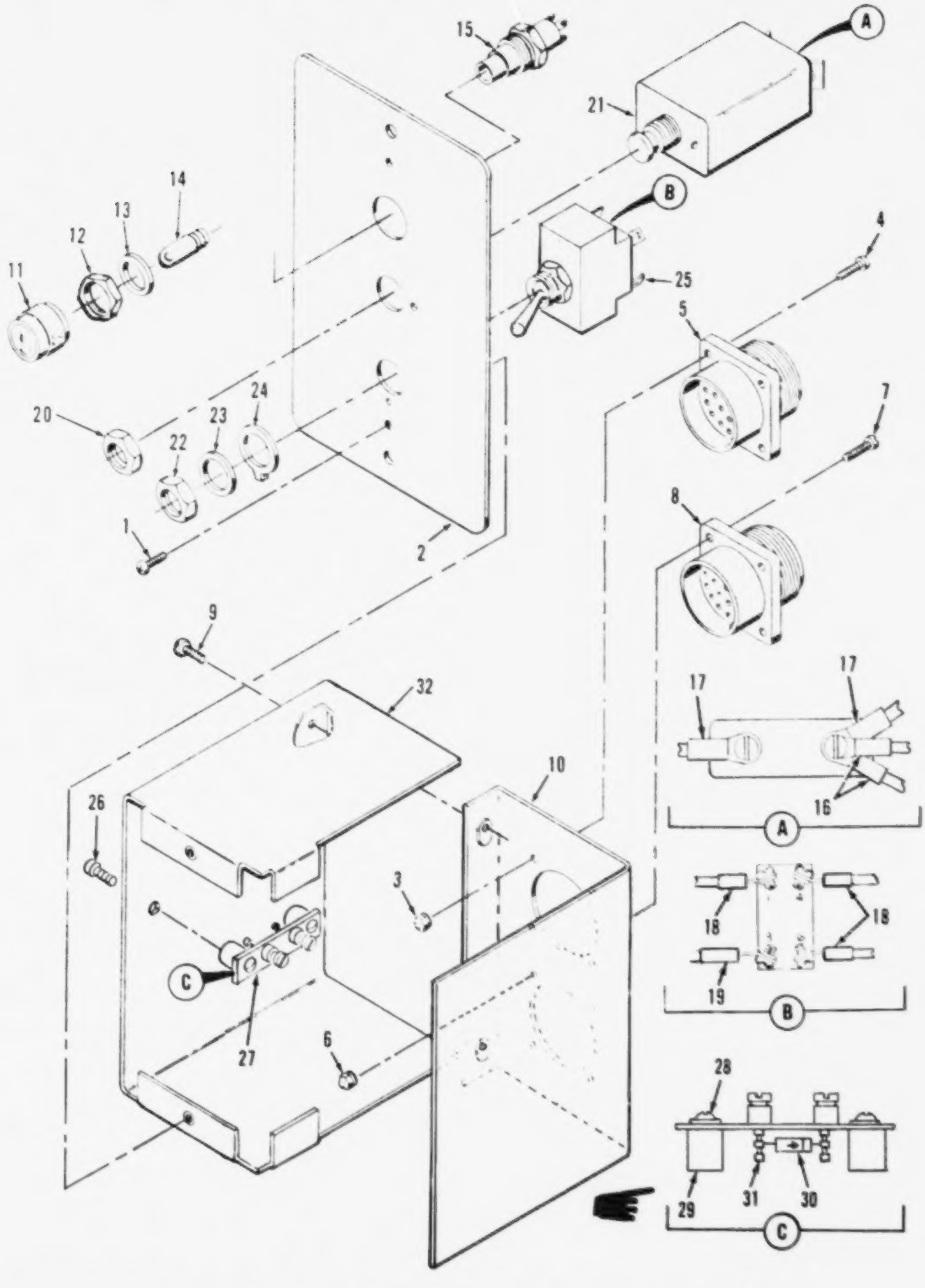

15
A
21
B
14
13
12
11
4
25
5
20
24
23
22
7
1
2
8
9
32
17
17
10
16
A
26
3
18
18
18
19
B
C
27
6
28
29
31
30
C

Figure 11-1. Fuel burning winterization kit control box, exploded view

Legend to figure 11-1:

1. Screw (2)
2. Plate
3. Nut assembly (4)
4. Screw (4)
5. Connector
6. Nut assembly (4)
7. Screw (4)
8. Connector
9. Screw (2)
10. Cover
11. Lens
12. Nut
13. Washer
14. Lamp
15. Indicator light
16. Terminal lug (2)
17. Terminal lug (2)
18. Terminal lug (3)
19. Terminal lug
20. Nut
21. Circuit breaker
22. Nut
23. Washer
24. Tab washer
25. Switch
26. Frame

Table 11-1. Fuel Burning Winterization Kit Control Box Wire Termination Data

| FROM | TERMINATION NOTE | TO | TERMINATION NOTE | WIRE TYPE | WIRE LENGTH INCHES |
|---|---|---|---|---|---|
| J26A | 3 | J27A | 3 | 1 | 3 |
| J26A | 3 | DS1-1 | 3, 4 | 2 | 4 |
| J26B | 3 | S1-1 | 5 | 2 | 5 |
| J26C | 3 | J27C | 3 | 1 | 3-1/2 |
| J26D | 3 | S1-6 | 6 | 1 | 6 |
| J26E | 3 | CB-1 | 7 | 1 | 3-1/2 |
| J26B | 3 | S1-3 | 5 | 2 | 6 |
| J27D | 3 | DS1-2 | 3, 4 | 2 | 5 |
| J27E | 3 | CB-2 | 7 | 1 | 6 |
| CB-2 | 8 | DS1-3 | 3, 4 | 2 | 3 |
| CB-2 | 8 | S1-4 | 5 | 2 | 3 |

NOTES:
1. Wire is M5086/2-12-9 per MIL-W-5086/2.
2. Wire is M5086/2-16-9 per MIL-W-5086/2.
3. Solder.
4. Make good mechanical connection before soldering.
5. Secure end with terminal lug, MS25036-106.
6. Secure end with terminal lug, MS25036-111.
7. Secure end with terminal lug, MS25036-156.
8. Secure end with terminal lug, MS25036-153.
9. Refer to Operator and Organizational Maintenance Manual for wiring diagram.

b. Inspect switch, indicator light, and circuit breaker for continuity. Refer to figure 1-21.

c. Inspect terminal lugs for security and condition.

d. Inspect components for dents, cracks, and distortion.

## 11-6. REPAIR.

NOTE

Figure 1-21 is the fuel burning winterization kit schematic. Wiring diagram contained in Operator and Organizational Maintenance Manual.

a. Repair or replace defective control box wiring in accordance with table 11-1.

b. Repair dents and distortion using proper tools.

## 11-7. REASSEMBLY.

Refer to figure 11-1 and reassemble control box in the reverse order of index numbers assigned. Pay particular attention to the following:

a. When installing switch (25), insert tab of tab washer (24) into hole of plate (2).

b. Install circuit breaker (21), indicator light (15), and lens (11).

c. Install connectors (5 and 8) with key located on the top.

d. Attach cover (10) to frame (26).

e. Connect wiring and check for proper connection, refer to table 11-1.

## 11-8. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install the control boxes.

# Section II. HEATER

## 11-9. GENERAL.

There are two identical heaters used in the fuel burning winterization kit. The heaters are a fuel burning type designed to per-heat the engine for starting at low temperatures down to -65°F by circulating heated coolant through the engine. The heater consists of a blower motor, fuel regulator valve, limit switch, igniter, flame switch, and a coolant pump. The blower motor and fan assembly provides air for combustion; it is also a means for driving the coolant pump. The fuel regulator valve permits the fuel to be turned on and off; it also regulates the fuel flow to the burner. The igniter, which is a high resistance glow plug, is used to vaporize and ignite the fuel. The flame switch controls the electrical supply to the igniter, blower motor and indicator lamp; it operation is determined by temperature. Recirculation of heated coolant is provided by the coolant pumps at a rate of 80 to 100 GPH. Coolant is circulated around each heater combustion chamber where it is heated and then is circulated through the engine.

## 11-10. REMOVAL.

Refer to Operatior and Organizational Maintenance Manual and remove the heaters.

## 11-11. DISASSEMBLY.

Refer to figure 11-2 and disassemble heater in the order of index numbers assigned. Pay particular attention to the following:

a. Remove cover (1). Tag and disconnect wires.

### CAUTION

Use care when removing quartz rod (14) as it is easily broken if dropped.

b. Remove receptacle assembly (3), terminal block (5), and flame switch assembly (8).

c. Remove igniter (18), gasket (19).

### NOTE

Do not remove regulator valve assembly (21) until after casting (40) has been removed.

d. Remove burner assembly (48), and motor and pump assembly (55) as a complete assembly.

### NOTE

Coolant pump (56) cannot be removed as a complete assembly. The unit must be disassembled during removal as the pump rotor (67) is secured to the motor shaft by a set screw (66).

e. Before disassembly of coolant pump, make an alignment mark across adapter (68), cam ring (63), and plate (58) for correct alignment during reassembly.

## 11-12. CLEANING.

a. Clean electrical components with a cloth moistened with an approved cleaning solvent, and dry thoroughly.

b. Remove carbon deposits from burner assembly using a suitable wire brush.

c. Clean orifice assembly by forcing filtered compressed air through orifice in the reverse flow direction.

d. Clean parts with an approved cleaning solvent, and dry thoroughly.

## 11-13. INSPECTION.

a. Inspect components for cracks, dents, distortion, burrs, nicks, and damaged threads.

b. Inspect insulation for damage.

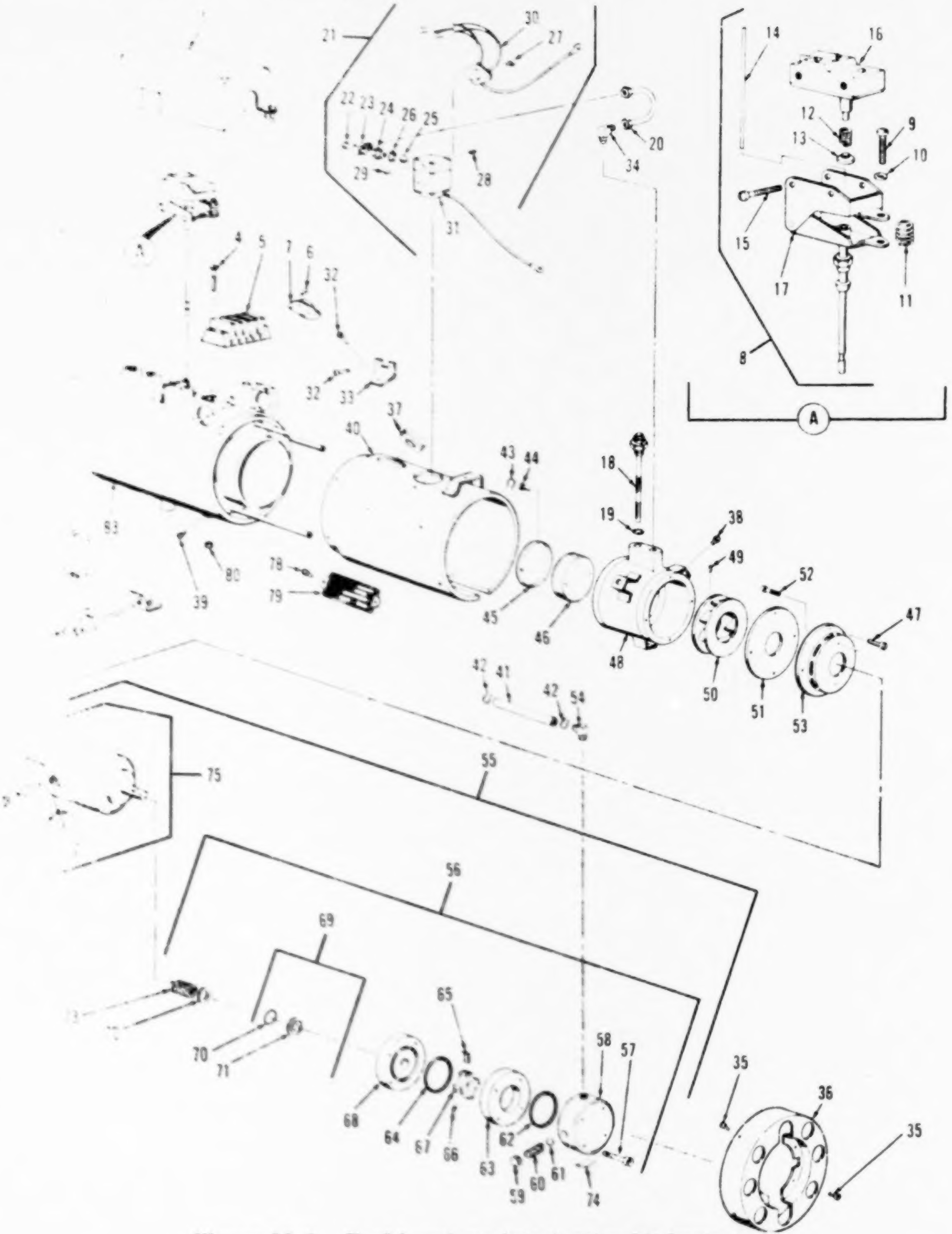
c. Inspect springs for condition. Inspect spring (60, figure 11-2). Using a suitable spring compressor, apply a load of 1 ± 0.1 pounds and compress spring (60) to a working length of 0.750 inch. Spring should measure 1.164 inches free length after test.

d. Inspect receptacle assembly for loose connections and bent or broken terminal pins. Check for short to case and surrounding pins. Check for continuity between wires and terminal pins.

e. Inspect orifice assembly for proper orifice opening. Opening should be 0.012 inch diameter.

f. Inspect regulator valve assembly (21) as follows:

1. Check resistance of solenoid coil; resistance should be 150 ohms.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74

Figure 11-2. Fuel burning winterization kit heater, exploded view

Legend to figure 11-2:

1. Cover
2. Screw (4)
3. Receptacle assembly
4. Screw (4)
5. Terminal block
6. Screw (2)
7. Limit switch
8. Flame switch assembly
9. Adjusting screw
10. Washer
11. Adjusting spring
12. Tension spring
13. Spring pad
14. Quartz rod
15. Screw (2)
16. Micro-switch
17. Switch frame assembly
18. Igniter
19. Gasket
20. Tube assembly
21. Regulator valve assembly
22. Plug
23. Orifice assembly
24. Body
25. Sintered filter
26. Gasket
27. Screw (2)
28. Set screw
29. Set screw
30. Fuel pre-heater assembly
31. Regulator valve assembly
32. Screw (6)
33. Bracket (2)
34. Elbow
35. Screw (8)
36. Cover
37. Grommet
38. Screw (3)
39. Screw (5)
40. Casing
41. Hose (2)
42. Clamp (4)
43. Lockwire
44. Screw (2)
45. Retainer
46. Vaporizer
47. Screw (4)
48. Burner assembly
49. Set screw
50. Fan
51. Plate
52. Screw (2)
53. Inlet
54. Elbow (2)
55. Motor and pump assembly
56. Coolant pump assembly
57. Screw (4)
58. Plate
59. Plug
60. Spring
61. Ball
62. O-ring
63. Cam ring
64. O-ring
65. Blade (4)
66. Set screw
67. Rotor
68. Adapter
69. Seal assembly
70. Seal cage
71. O-ring
72. Seal washer
73. Seal spring
74. Decal
75. Blower motor assembly
76. Brush cap (2)
77. Brush and spring (2)
78. Screw
79. Name plate
80. Drain plug
81. Clamp (2)
82. Bracket (2)
83. Heat exchanger

2. Test fuel flow. Connect filtered 7 PSI fuel supply to regulator valve, and apply 24 VDC to valve solenoid.

3. Using a stop watch, time the fuel flow into a graduated container. Flow should measure 21 to 23 cubic centimeters per minute (approximately 1/4 pint in five minutes).

4. If fuel flow rate is not within these tolerances, adjust valve. Turn adjusting screw clockwise to increase flow rate or counterclockwise to decrease flow rate.

5. Remove 24 VDC from valve solenoid, and check for leakage through valve.

6. Remove test equipment from valve. Replace valve that will not provide proper fuel flow or one that leaks when voltage is removed.

g. Inspect flame switch assembly (8) as follows:

1. Inspect frame for loose pivot points.

2. Check continuity of micro-switch (16) as follows:

(a) Depress the micro-switch button. This will be the ignition or start position of the switch. Continuity should be indicated between the two NO terminals and also between each of the NO terminals and the common terminal. There should be an open circuit between the two NC terminals and also between the common terminal and the two NC terminals.

(b) Release the micro-switch button. This will be the run position of the micro-switch. Continuity should be indicated between the two NC terminals and the common terminal. There should be an open circuit between the NO ignition or start terminals and between the NO terminals and the common terminal.

h. Inspect igniter as follows:

1. Inspect for broken coil or short.

2. Check igniter for proper resistance; resistance should be 1 ohm.

WARNING

To prevent burns, do not touch igniter during test, and allow enough time for it to return to ambient temperature before removing test equipment.

3. Connect 24 VDC power source and an ammeter to igniter terminal. Ground igniter. Apply 24 VDC to igniter. The igniter should draw 10.5 amperes and heat to a bright red color in a few seconds.

i. Inspect fan for loose or damaged blades.

j. Inspect heat exchanger and burner assembly for warpage and burned areas.

k. Inspect sintered filter for blockage.

l. Using a suitable dial indicator, check end play on shaft of blower motor assembly. Grasp short shaft end and rotate in one direction, at the same time moving it in and out. The end play should not exceed [illegible] to 0.025 inch.

m. Inspect adapter for damaged or scored face, warped condition, and damaged seal face. Inspect for motor shaft bore wear. Refer to figure 11-3 for limits.

n. Inspect seal cage for scored or damaged seal face.

o. Inspect rotor and blades for damage and wear. Refer to figure 11-3 for limits.

p. Inspect cam ring for damaged or scored bore. Inspect for warped condition. Both faces must be parallel within 0.001 inch T.I.R.

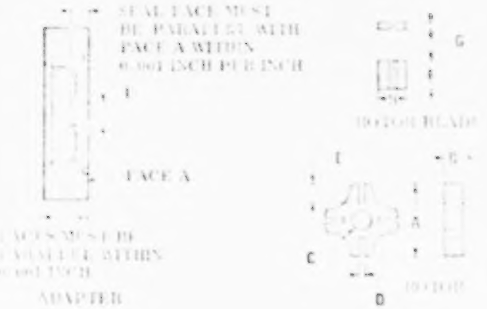
q. Inspect plate (58, figure 11-2) for damaged or scored face.

## 11-14. REPAIR.

a. Seal face of adapter (68, figure 11-2) and seal face of seal cage (71) can be dressed to remove minor nicks, scratches or scoring. Remove only material necessary to clean up seal face. Seal face must be parallel with rotor side of adapter within 0.001 inch per inch. Replace either part if imperfections cannot be dressed out.

b. Straighten distorted parts using suitable tools.

c. Remove burrs or nicks using a stone or file.


SEAL FACE MUST BE PARALLEL WITH FACE A WITHIN 0.001 INCH PER INCH
F
FACE A
FACES MUST BE PARALLEL WITHIN 0.001 INCH
ADAPTER
G
H
ROTOR BLADE
E
B
A
C
D
ROTOR

| ITEM | DIMENSION | DIMENSIONAL LIMITS (INCHES) |
|---|---|---|
| ROTOR HEAD DIAMETER | A | [illegible] |
| ROTOR HEAD LENGTH | B | [illegible] |
| ROTOR BORE DIAMETER | C | [illegible] |
| ROTOR BLADE SLOT WIDTH | D | [illegible] |
| ROTOR BLADE SLOT DEPTH | | [illegible] |
| BLADE HEIGHT | | 0.247-0.249 |
| BLADE THICKNESS | | 0.091-0.093 |
| BLADE WIDTH | H | 0.247-0.249 |
| ADAPTER BORE DIAMETER | F | [illegible] |

Figure 11-3. Coolant pump wear limits

## 11-15. REASSEMBLY.

**Refer to figure 11-2 and reassemble heater in the reverse order of index numbers assigned. Pay particular attention to the following:**

NOTE

The coolant pump (56) cannot be assembled completely and installed as a separate unit. It is assembled as it is installed on the short shaft end of the motor.

a. Apply a thin film of grease to o-rings (62, 64, and 70) and seal cage (71).

b. Install seal spring (73) and seal washer (72) over end of motor shaft. Place o-ring (70) in seal cage (71); then install seal cage over end of motor shaft with seal face facing outward.

c. Install pump adapter (68) over motor shaft and align holes with tapped holes in motor.

NOTE

Make certain that adapter (69) and cam ring (63) are tightly compressed together when determining the 0.002 inch clearance, otherwise a false reading will be obtained.

d. Install pump rotor (67) on motor shaft and temporarily tighten rotor set screw (66). Place o-ring (64) in groove of pump adapter (68). Place cam ring (63) in position aligning scribe mark. With motor shaft end play taken up in direction of pump, make certain there is at least 0.002 inch clearance between outer face of cam ring (63) and outer face of rotor (67). Move rotor back or forth as necessary to produce this clearance; then tighten set screw (66).

e. Install rotor blades (65) in rotor slots, making sure that grooves in blades face away from direction of rotation. Pump rotates counterclockwise when viewing end of port plate (58).

f. Place o-ring (62) in groove of port plate (58); then position plate against cam ring (63). Align scribe marks, and tighten screws (57) evenly.

g. Test coolant pump assembly (56). Refer to paragraph 11-16, step a.

h. After coolant pump has been reassembled and tested, flush with corrosive preventive compound, Military Specification MIL-C-6529, and drain.

NOTE

Make certain that the lead wire from blower motor assembly (75) is on the side of the blower opposite the name plate.

i. Assemble motor and pump assembly (55), inlet (53), plate (51), and fan (50) before installing into burner assembly (48).

j. Install burner assembly (48) and casing (40).

k. Install cover (36).

l. Install regulator valve assembly (21), gasket (19), and igniter (18).

CAUTION

Use care when installing quartz rod (14) as it is easily broken if dropped.

m. After installing quartz rod (14), gently raise the rod up and down to see if it moves freely in the stainless tube. Also make sure at least 1/32 inch extends out of tube when rod is resting on bottom.

n. Install flame switch assembly (8) and terminal block (5).

o. Install receptacle assembly (3) with key located on the top.

p. Adjust flame switch (8), refer to paragraph 11-16, step b.

q. Install cover (1).

## 11-16. COMPONENT TEST AND ADJUSTMENTS.

The following procedures cover testing and adjustments of individual components.

a. Coolant Pump Assembly. Coolant pump assembly (56, figure 11-2) should be tested before being reinstalled in the heater. Test coolant pump assembly as follows:

1. Connect motor and pump assembly to equipment as shown in figure 11-4.

2. Turn power switch to ON and run-in unit for approximately 15 minutes.

3. Test relief valve by closing manual shut-off valve. Discharge pressure should not exceed 30 to 35 PSI when valve is closed. Open and close valve a few times to check consistency of valve performance. Replace relief valve spring if pressure exceeds 30 to 35 PSI.

4. To check pump for rated flow and pressure, adjust valve in discharge line until a reading of 2 PSI is obtained on pressure gauge.

5. Using a suitable timer, check for rated flow of 80 GPH minimum at 2 PSI discharge pressure. Amperage draw should not exceed 6 amperes during this test.

6. Check motor RPM using a strobe light. Motor shaft speed should be 8500 RPM.

7. Observe smoothness of operation of both pump and motor. Seal leakage of 1 cubic centimeter per hour (seal may show

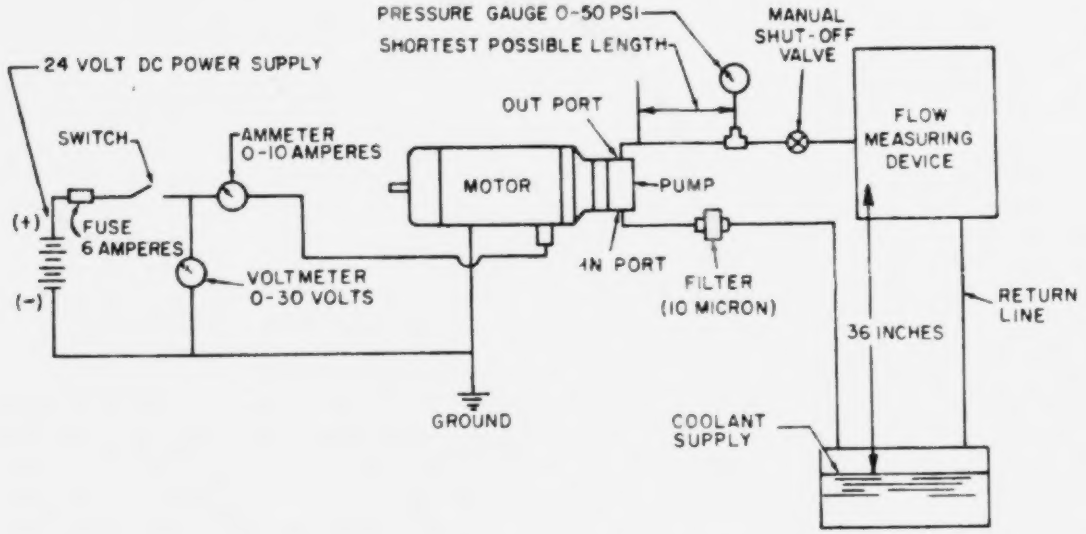

PRESSURE GAUGE 0-50 PSI
SHORTEST POSSIBLE LENGTH
MANUAL SHUT-OFF VALVE
24 VOLT DC POWER SUPPLY
OUT PORT
FLOW MEASURING DEVICE
SWITCH
AMMETER 0-10 AMPERES
MOTOR
PUMP
(+)
FUSE 6 AMPERES
VOLTMETER 0-30 VOLTS
(-)
IN PORT
FILTER (10 MICRON)
RETURN LINE
36 INCHES
GROUND
COOLANT SUPPLY

Figure 11-4. Coolant pump test set-up

signs of dampness) is maximum when pump is operating at 2 PSI discharge pressure.

8. Turn power supply to OFF; then remove discharge line and fitting from OUT port. Plug this port and apply 40 PSI hydrostatic pressure for 20 minutes. No leakage shall be evident during this test.

9. Remove test equipment.

b. Flame Micro-Switch. Check microswitch (16, figure 11-2) as follows:

1. Connect a 24 VDC power supply to heater receptacle, positive to pin C and negative to pin A.

2. Turn adjusting screw (9) counterclockwise until motor starts.

3. Then turn adjusting screw clockwise until motor stops.

4. Turn adjusting screw clockwise an additional 1/2 (180 degrees) turn.

5. Remove power supply.

## 11-17. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install the heaters.

# CHAPTER 12

## ELECTRIC WINTERIZATION KIT REPAIR INSTRUCTIONS

## Section I. CONTROL BOX

### 12-1. GENERAL.

The control box contains the operating controls of the electric winterization kit. Incorporated in the box are the on-off switch, fuse, step down transformer, full wave diode rectifier, and heater indicator. The switch turns kit components on or off and the fuse protect kit components from excessive current. The step down transformer converts input voltage from external power supply to 33 VAC which in turn is converted to approximately 24 VDC by the full wave diode rectifier for coolant pump operation. The indicator illuminates whenever the kit is in operation.

### 12-2. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove the control box.

### 12-3. TEST.

NOTE

Figure 1-22 is the electric winterization kit schematic.

a. Connect control box to test equipment as illustrated in figure 12-1.

b. Perform test procedures as specified in table 12-1.

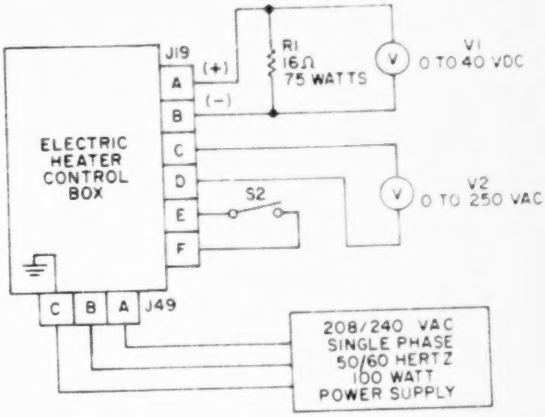


Figure 12-1. Electric winterization kit control box, test setup

### 12-4. DISASSEMBLY.

Refer to figure 12-2 and disassemble electric winterization kit control box in the order of index numbers assigned. Pay particular attention to the following:

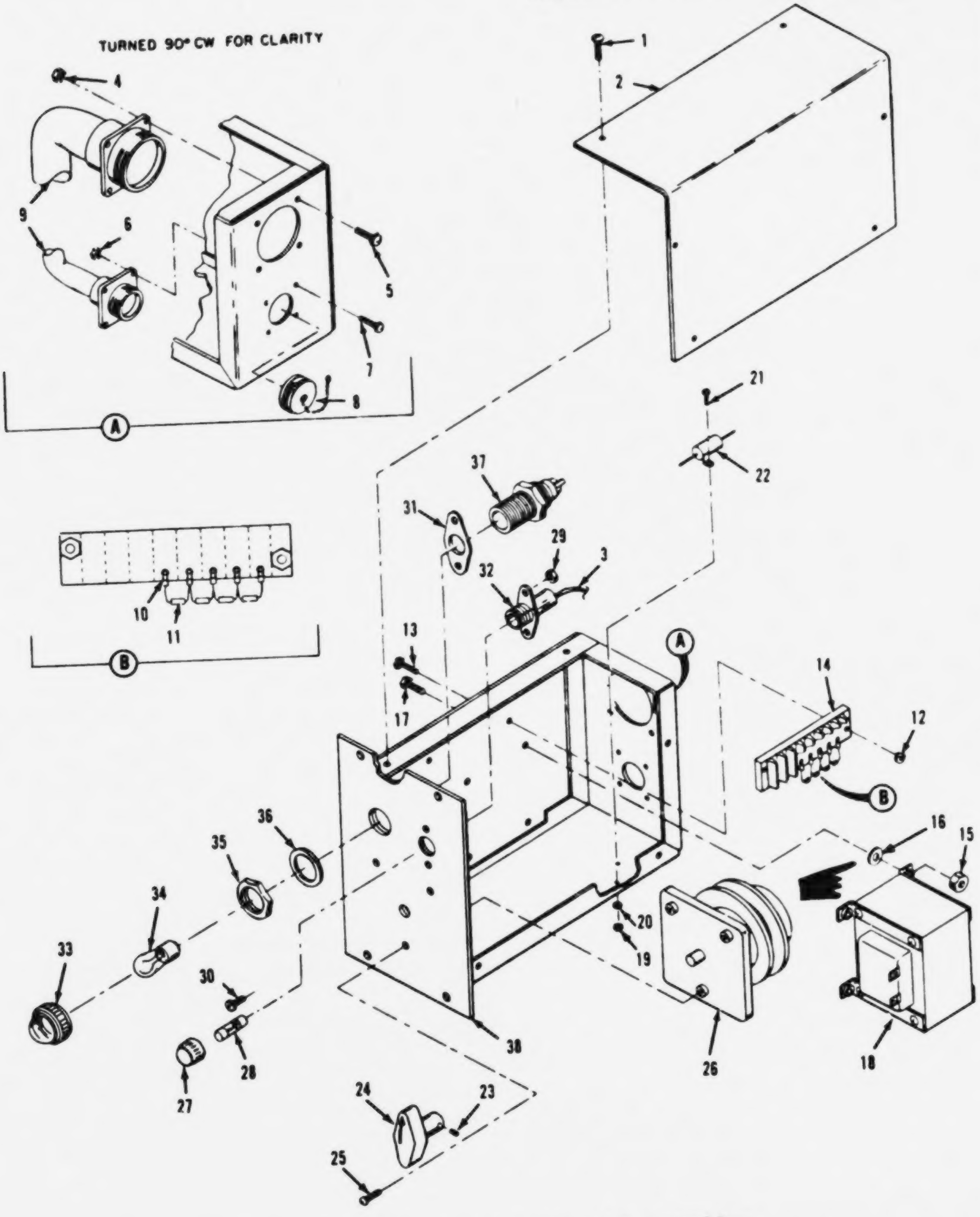
a. Prior to control box disassembly, test box as specified in paragraph 12-3 and then disassemble control box only to the extent necessary to accomplish repair.

b. Remove cover (2). Tag and disconnect harness wires from components and remove harnesses (3 and 9).

c. Tag diodes (11) with location and polarity and remove diodes from terminal strip by removing terminal strip screws.

Table 12-1. Electric Winterization Kit Control Box Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURES |
|---|---|---|---|---|
| 1. | Position heater control box switch to ON and apply 230 VAC. Close switch S2, refer to figure 13-1. | a. Heater control box indicator DS1 should illuminate. | Defective resistor R20.<br>Defective indicator DS11. | Check resistor value which should be 2.47K ohms.<br>Check indicator for continuity. There should be continuity. |
| 2. |  | b. Voltmeter V2 should indicate 230 VAC. | Defective transformer T1. | Measure voltage across secondary leads of T1 with a 0 to 50 VAC voltmeter. Voltage should be approximately 33 VAC. |
|  |  | c. Voltmeter V1 should indicate approximately 33 VAC. | Defective diodes CR23, CR24, CR25, or CR26. | Check forward and reverse resistance of diodes. Measure from anode (+) to cathode (-), value should be low. Reverse meter leads, value should be infinity. |


TURNED 90° CW FOR CLARITY
4
9
6
5
7
8
A
10
11
B
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2
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22
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3
32
13
17
A
14
12
B
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38
26
18
24
23
25

Figure 12-2. Electric winterization kit control box, exploded view

Legend to figure 12-2:

1. Screw (6)
2. Cover
3. Harness
4. Nut (4)
5. Screw (4)
6. Nut (4)
7. Screw (4)
8. Cover
9. Harness
10. Terminal lug (8)
11. Diode (4)
12. Nut (2)
13. Screw (2)
14. Terminal board
15. Nut (4)
16. Washer (4)
17. Screw (4)
18. Transformer
19. Nut (2)
20. Lock washer (2)
21. Screw (2)
22. Resistor
23. Setscrew
24. Knob
25. Screw (3)
26. Switch
27. Cap
28. Fuse
29. Nut (2)
30. Screw (2)
31. Plate
32. Fuse holder
33. Lens
34. Lamp
35. Nut
36. Washer
37. Light housing
38. Chassis

## 12-5. CLEANING.

a. Clean electrical components with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

b. Clean remaining parts in an approved cleaning solvent and dry thoroughly.

## 12-6. INSPECTION.

a. Inspect sheet metal parts for cracks, distortion, dents, and bent corners.

b. Check threads for damage.

c. Inspect terminal board for damaged or cracked insulation.

NOTE

Figure 1-22 is the schematic for the electric winterization kit.

d. Check resistor for proper resistance value, value should be 2.47K ohms.

e. Check switch, lamp, light, fuse, and fuse holder for continuity.

f. Check forward and reverse resistance of diodes. Measured from anode (+) to cathode (-), value should be low. Reverse meter leads, value should be infinity.

g. Inspect transformer for burrs and defective insulation. Apply 240 VAC to transformer terminals 1 and 2. Check output at terminals 3 and 4, output should be 33 VAC.

h. Inspect harness (3, figure 12-2) wires for continuity, refer to figure 12-3.

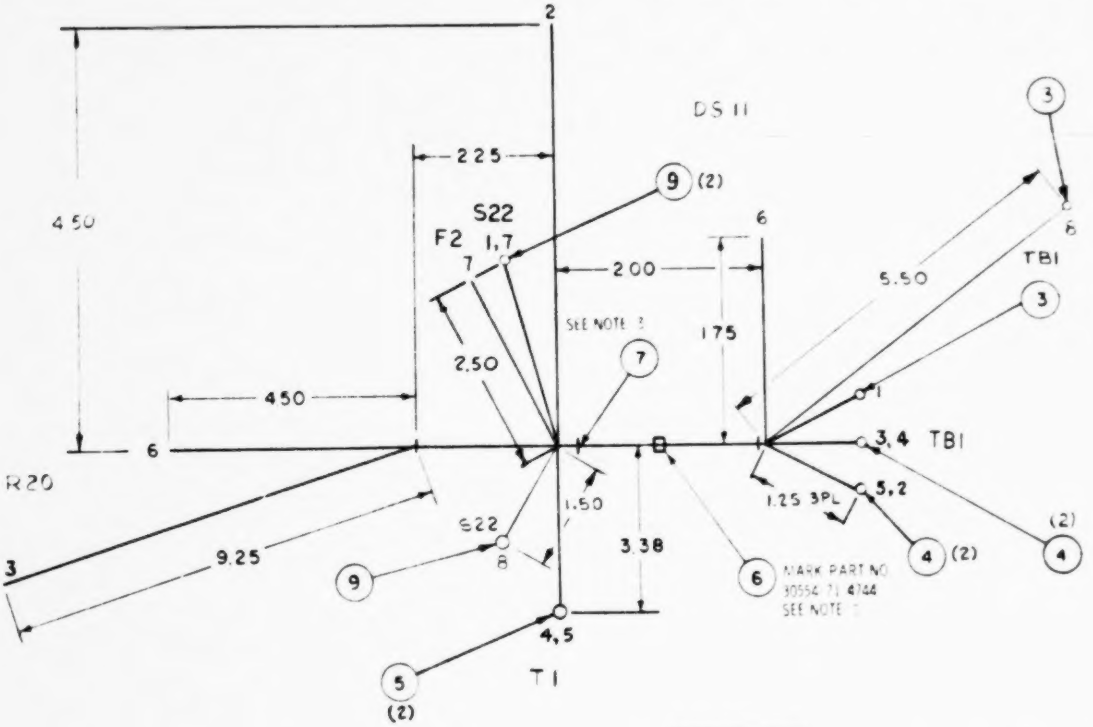
i. Inspect harness (9, figure 12-2) connectors for bent, loose, or missing pins. Check each harness wire for continuity from wire ends to connector pins. Check connector pins for shorts to case and surrounding pins. Refer to figure 12-4.

## 12-7. REPAIR.

a. Straighten dented or distorted parts using proper tools.

b. Repair or rebuild defective harness (3, figure 12-2) as illustrated in figure 12-3.

c. Repair or rebuild defective harness (9, figure 12-2) as illustrated in figure 12-4.



NOTES

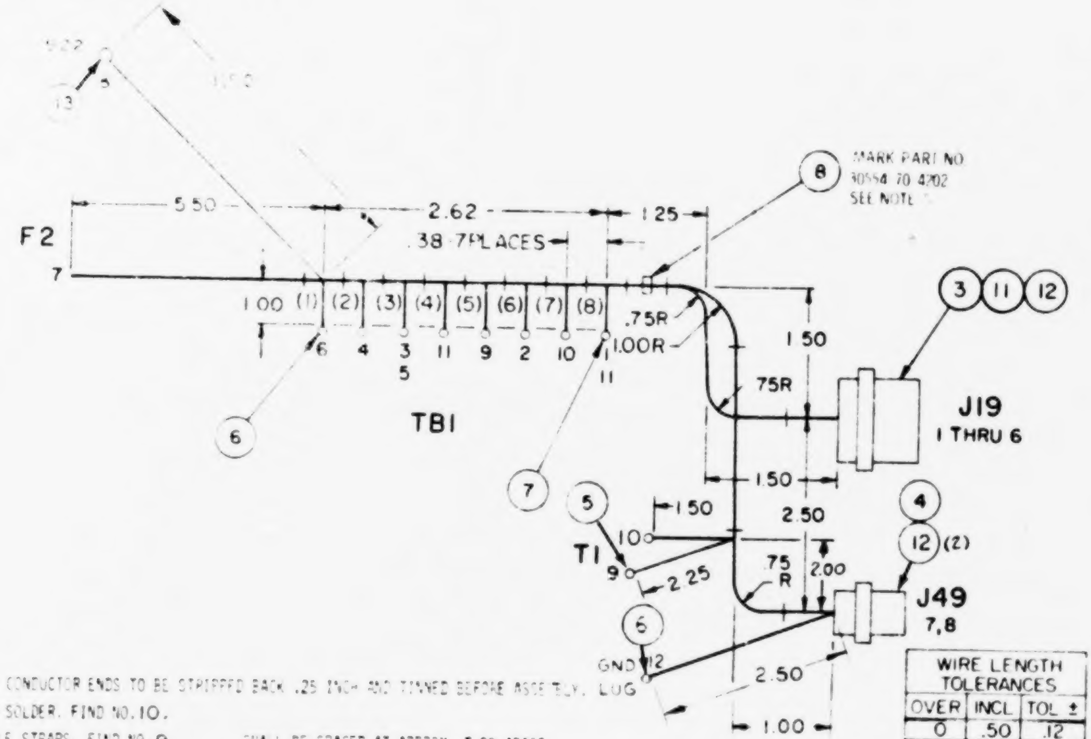
1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 8.
3. CABLE STRAPS, FIND NO. 7 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE NO | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | X303A12 | TB1-1 | 3 | S22-13 | 9 | 5.50 |
| 2 | BLACK | X304F16 | TB1-3 | 4 | DS11-1 | - | 7.50 |
| 3 | BLACK | X301A16 | TB1-2 | 4 | R20-2 | - | 14.50 |
| 4 | BLACK | X301D16 | TB1-2 | 4 | T1-2 | 5 | 6.75 |
| 5 | BLACK | X304C16 | TB1-3 | 4 | T1-1 | 5 | 7.00 |
| 6 | BLACK | X305A16 | R20-1 | - | DS11-2 | - | 11.00 |
| 7 | BLACK | LOOSE WIRE | F2-2 | - | S22-12 | 9 | 5.00 |
| | * | 12 GA | | | | | |
| 8 | BLACK | X301C12 | TB1-2 | 3 | S22-17 | 9 | 9.00 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 9 | | | MS25036-156 | 3 | TERMINAL, LUG, CRIMP STYLE | | |
| 8 | | | SN60WRAP2 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-571 | |
| 7 | | | MS3367-4-9 | 4 | STRAP, TIEDOWN | | |
| 6 | | | MS39020-1 | 1 | BAND, MARKER | | |
| 5 | | | MS25036-153 | 2 | TERMINAL, LUG, CRIMP STYLE | | |
| 4 | | | MS25036-106 | 4 | TERMINAL, LUG, CRIMP STYLE | | |
| 3 | | | MS25036-111 | 2 | TERMINAL, LUG, CRIMP STYLE | | |
| 2 | | | M5086/2-12-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| 1 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

Figure 12-3. Electric winterization kit control box wiring harness


S22
13
5
5.50
2.62
1.25
.38 7PLACES
F2
7
1.00
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
6
4
3
5
11
9
2
10
11
11
TB1
6
7
8
MARK PART NO
30554 70 4202
SEE NOTE
.75R
1.00R
1.50
75R
3
11
12
J19
1 THRU 6
1.50
5
1.50
10
2.50
T1
9
2.25
.75
R
2.00
4
12 (2)
J49
7,8
6
GND
12
LUG
2.50
1.00

NOTES:

ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY. USE SOLDER, FIND NO. 10.

CABLE STRAPS, FIND NO. 9 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.

WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN

PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

| WIRE NO | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO | TO | TERMN FIND NO | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | [illegible] | J19-A | 3 | [illegible] | [illegible] | 4.75 |
| 2 | BLACK | [illegible] | J19-B | ↕ | [illegible] | [illegible] | [illegible] |
| 3 | BLACK | X304B12 | J19-C | | TB1-3 | 6 | 8.75 |
| 4 | BLACK | [illegible] | J19-D | | TB1-2 | 6 | 9.50 |
| 5 | BLACK | X304A12 | J19-E | | TB1-3 | 6 | 8.75 |
| 6 | BLACK | X303C12 | J19-F | 3 | TB1-1 | 6 | 10.25 |
| 7 | BLACK | X302A12 | J49-A | 4 | F2-1 | - | 14.00 |
| 8 | BLACK | X301F12 | J49-B | 4 | S22 16 | 13 | 20.00 |
| 9 | BLACK | [illegible] | TB1-5 | 7 | [illegible] | [illegible] | 7.50 |
| 10 | BLACK | [illegible] | TB1-7 | 7 | [illegible] | 5 | 6.00 |
| 11 | BLACK | V307A16 | TB1-4 | 7 | TB1-6 | 7 | 2.50 |
| 12 | JUMPER #12 GA | | [illegible] | 4 | [illegible] | — | 2.50 |

| FIND NO | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|---|
| 13 | MS25036-156 | 1 | TERMINAL, LUG CRIMP STYLE | |
| 12 | TYPE F, FORM UA<br>GRADE A, CL 1<br>CATEGORY 1 | .5 | TUBING, INSULATION<br>.148 ID X .020 WALL X .62 LG | MIL-I-631 |
| 11 | TYPE F, FORM UA<br>GRADE A, CL 1<br>CATEGORY 1 | 2 | TUBING, INSULATION<br>.106 ID X .016 WALL X .62 LG | MIL-I-631 |
| 10 | SN60WRAP2 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-571 |
| 9 | MS3367-4-9 | 14 | STRAP, TIEDOWN | |
| 8 | MS39020-1 | 1 | BAND, MARKER | |
| 7 | MS25036-106 | 6 | TERMINAL, LUG, CRIMP STYLE | |
| 6 | MS25036-111 | 5 | TERMINAL, LUG, CRIMP STYLE | |
| 5 | MS25036-153 | 2 | TERMINAL, LUG, CRIMP STYLE | |
| 4 | MS3102R16-10P | 1 | CONNECTOR, RECEPTACLE | |
| 3 | MS3102R28-9S | 1 | CONNECTOR, RECEPTACLE | |
| 2 | M5086/2-12-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 |
| 1 | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 |

Figure 12-4. Electric winterization kit control box connector wiring harness

### 12-8. REASSEMBLY.

Refer to figure 12-2 and reassemble the electric winterization kit control box in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Install connectors of harness (9) with keyways on top.

NOTE

Refer to Operator and Organizational Maintenance Manual for electric winterization kit wiring diagram.

b. Prior to installing cover (2), refer to figure 1-30 and check wiring for proper connection.

c. After reassembly, test control box as specified in paragraph 12-3.

### 12-9. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install the control box.

## Section II. ELECTRIC HEATER

### 12-10. GENERAL.

The electric heater is utilized to preheat generator set engine coolant during cold weather operation. The heater consists of a removable heating element, intake head with integral check valve and coolant tank. The check valve insures that the coolant tank is always full and heating element is submerged in coolant. The heating element heats the coolant in the tank which is in turn circulated through the engine coolant system.

### 12-11. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove the electric heater.

### 12-12. DISASSEMBLY.

Refer to figure 12-5 and disassemble the electric heater in the order of index numbers assigned.

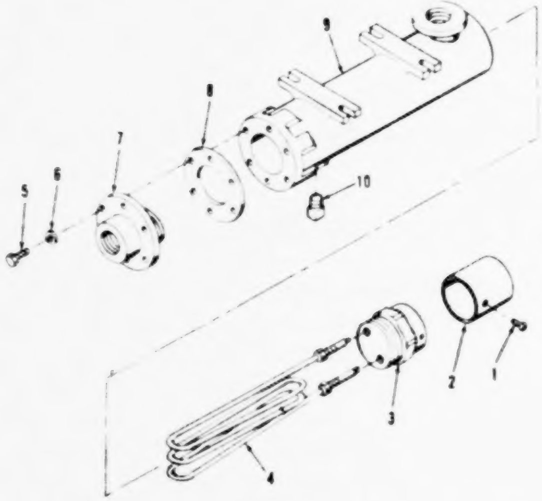


Figure 12-5. Electric winterization kit electric heater, exploded view

Legend to figure 12-5:

1. Screw
2. Cover
3. End Plug
4. Heating element
5. Screw (6)
6. Washer (6)
7. Intake head and check valve assembly
8. Gasket
9. Tank
10. Plug

## 12-13. CLEANING.

a. Remove hand coolant deposits from components by boiling components a minimum of 30 minutes in solution of one pound baking soda to each gallon of water.

b. Clean old gasket from intake head and check valve assembly and tank using a suitable scraper. Exercise care not to gouge surfaces.

c. Clean parts with an approved cleaning solvent and dry thoroughly.

## 12-14. INSPECTION.

a. Inspect threads for damage.

b. Inspect parts for cracks and damaged gasket surfaces.

c. Check flap of check valve for freedom of movement and for proper seating on intake head.

### WARNING

Do not handle heating element during test and permit element to cool prior to removing test equipment.

d. Connect single phase 240 volts, 50, or 60 hertz power supply to heating element terminals. Connect suitable ammeter and wattmeter in series with heating element and power supply. Apply 240 VAC and observe ammeter and wattmeter. Heating element should draw 6.6 amperes and 1584 watts. Remove test equipment, replace defective heating element.

## 12-15. REASSEMBLY.

Refer to figure 12-5 and reassemble the electric heater in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Apply thread sealing compound conforming to Military Specification MIL-S-45180, type III, to threads of end plug (3) and plug (9) prior to installation.

b. When installing intake head and check valve assembly (7), make sure that hole with arrow is on top.

## 12-16. INSTALLATION.

Refer to Operator and Organizational Manual and install the electric heater.

## Section III. COOLANT PUMP

## 12-17. GENERAL.

The coolant pump consists of a pump and motor assembly which operates on 24 VDC and provides a minimum of 80 gallons (302.8 liters) per hour at 2 PSI (.140 kg/sq cm). The motor is a continuous duty type and rotates in a clockwise direction as viewed from the pump end. The motor is rated at 20 to 32 VDC, 3.3 amperes with a mximum of 7500 RPM. The motor is equipped with an internal bypass and feed thru capacitor for radio suppression and voltage and current protection. The pump is a rotor type with a built in relief valve that is set at 30 to 35 PSI (2.109 to 2.461 kg/sq cm). If coolant pressure reaches 30 to 35 PSI (2.109 to 2.461 kg/sq cm), the relief valve ball is unseated and coolant is permitted to bypass internally within the pump until pressure is reduced to 30 PSI (2.109 kg/sq cm).

### 12-18. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove coolant pump.

### 12-19. TEST.

a. Connect coolant pump to test equipment as illustrated in figure 11-4, except test equipment fuse rating should be 4 amperes.

b. Perform test procedure specified in paragraph 11-16, step a. Test results during test should be the same as provided in test procedure except motor amperage draw should not exceed 3.3 amperes in step a.5. and motor RPM in step a.6. should be 7500.

### 12-20. DISASSEMBLY.

Refer to figure 12-6 and disassemble the coolant pump in the order of index numbers assigned. Pay particular attention to the following:

a. Mark alignment marks on port plate (6), cam ring (8), adapter (13), and motor (23) prior to disassembly to insure proper reassembly.

b. Move shell (22) away from motor and unsolder wire (20) from pump.

c. Replace all packings.

### 12-21. CLEANING.

a. Clean wire and motor with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

b. Clean brush and spring assembly and brush openings with filtered low pressure compressed air.

c. Clean remaining parts in an approved cleaning solvent and dry thoroughly.

### 12-22. INSPECTION.

a. Inspect springs for cracks, distortion, and broken ends.

b. Test relief valve spring for proper spring rate using a suitable spring tester. Spring rate should be 1 pound ± 0.1 pound at 0.750 inch working length. After rate test, check spring for proper free length of approximately 1.164 inches.

c. Test seal spring for proper spring rate. Spring rate should be 2.5 pounds ± 0.25 pound at 0.25 inch working length. After rate test, check spring for proper free length of approximately 0.470 inch.

d. Inspect relief valve ball and ball seat in port plate for grooves, scratches, and nicks.

e. Inspect parts for cracks, damaged contact surfaces, signs of scuffing, nicks, and burrs.

f. Inspect threads for damages.

g. Inspect pump components for wear, refer to figure 11-3.

h. Inspect brush and spring assembly brushes for cracks, chips, and wear by comparing brush with new brush. Replace brush and spring assembly if brush is worn to half its original length.

i. Rotate motor shaft and check for smoothness of rotation, rough spots, and excessive side play. Using a suitable dial indicator, check motor shaft end play. End play should be 0.010 to 0.025 inch. Check motor shaft for wear, shaft should be 0.3125 ± 0.0005 inch diameter and 0.286 ± 0.005 inch from flat. Check shaft for grooves on packing contact surface.

j. Check capacitor for open or short.

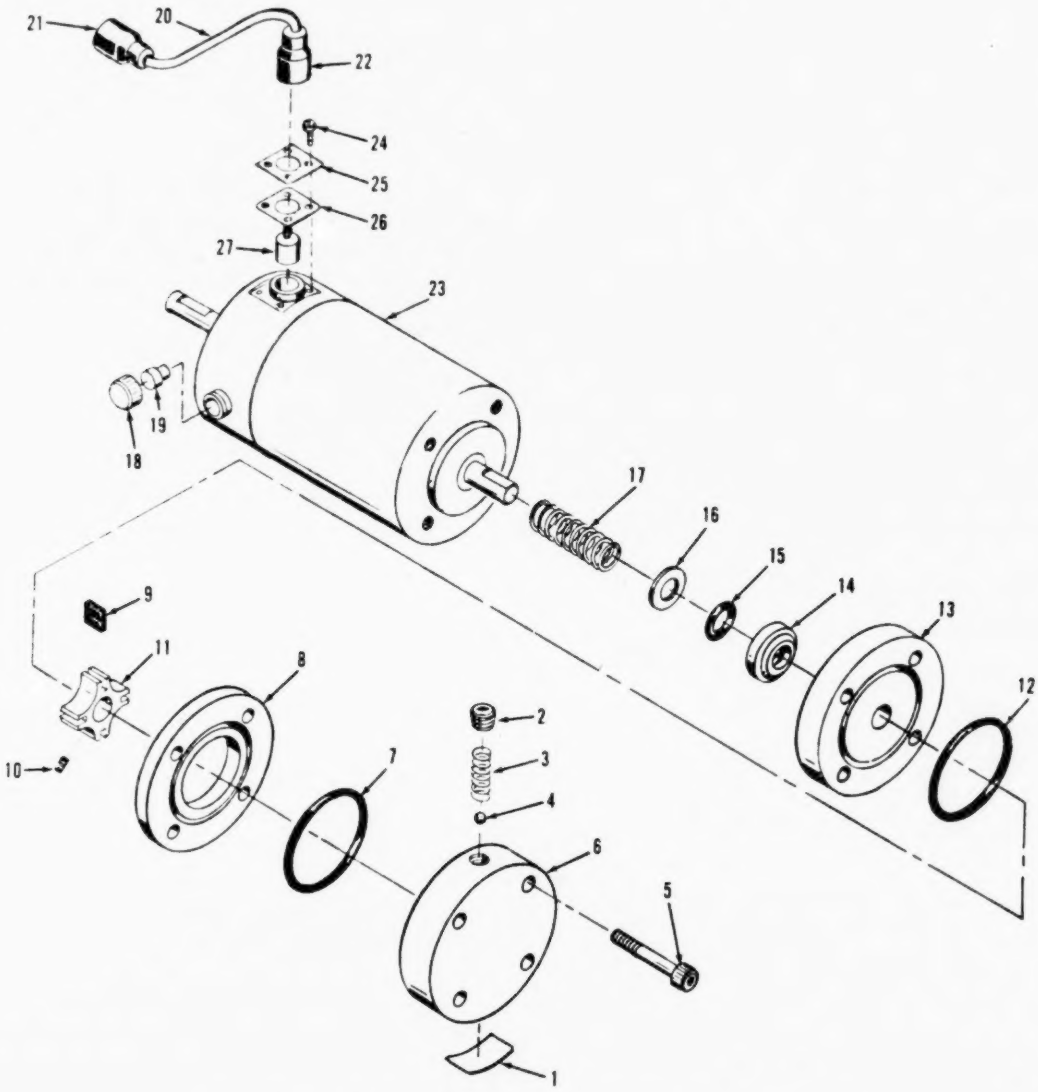

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Figure 12-6. Electric winterization kit coolant pump, exploded view

k. Connect 24 VDC and ammeter to motor terminal and ground motor. Check motor RPM using a suitable strobe light. Motor should draw a maximum of 3.3 amperes and RPM should be approximately 7500.

## 12-23. REPAIR.

a. Remove nicks and burrs using a stone or file.

b. Repair loose nameplate using a suitable adhesive.

Legend to figure 12-6:

1. Nameplate
2. Plug
3. Relief valve spring
4. Relief valve ball
5. Screw (4)
6. Port plate
7. Packing
8. Cam ring
9. Blade (4)
10. Setscrew
11. Rotor
12. Packing
13. Adapter
14. Seal cage
15. Packing
16. Washer
17. Seal spring
18. Brush cap (2)
19. Brush and spring assembly (2)
20. Wire
21. Shell
22. Shell
23. Motor
24. Screw (4)
25. Plate
26. Gasket
27. Capacitor

## 12-24. REASSEMBLY.

Refer to figure 12-6 and reassemble the coolant pump in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Solder wire (20) to motor and position shell (22) on motor to ensure water tight seal.

b. Apply a thin film of grease to packings (7, 12, and 15) and seal cage (14) so that packing will move in groove to form proper seal at time of reassembly. Position packings in grooves.

c. Install blades (9) in rotor (11). Align alignment marks.

d. Position spring (17), washer (16), packing (15), seal cage (14), adapter (13), and assembled rotor (11) on motor shaft. Align motor setscrew opening with flat of motor shaft. Slide components toward motor, compressing spring (17) and install setscrew (10).

e. Install remaining components. Tighten screws (5) evenly to prevent side loading components.

f. Test coolant pump as specified in paragraph 12-19.

## 12-25. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install coolant pump.

# CHAPTER 13

# DUMMY LOAD KIT REPAIR INSTRUCTIONS

## Section I. DUMMY LOAD KIT

### 13-1. GENERAL.

The dummy load kit is a balanced three phase, four wire, resistive type load bank. The kit is rated for approximately 100 KW with increments loads of approximately 25 KW. It is capable of operating with either 50/60 hertz or 400 hertz generator sets. The kit consists of a control box, resistive heater elements, and wiring enclosed in a ventilated housing. The kit is designed to operate at either 120/208 or 240/416 output voltages. The kit's load is created by the heater elements, as selected by the load switch. The control box and its components are described in Section II of this chapter.

### 13-2. REMOVAL.

Refer to Operator and Organizational Maintenance Manual and remove dummy load kit.

### 13-3. DISASSEMBLY.

Refer to figure 13-1 and disassembly dummy load kit in the order of index numbers assigned. Pay particular attention to the following.

NOTE

Disassemble dummy load kit only to the extent necessary to effect repair.

a. Remove cover assembly (6), side panels (17) channels (18 and 19) and end panels (23 thru 26) from frame (76).

b. Tag, disconnect, and remove leads (29) from heater elements (34). Remove heater elements (34), resistor brackets (39, 44, 49, and 54) from frame (76).

c. Remove control box cover (62), tag and disconnect wire harnesses (58 and 59) from control box components.

d. Separate control box (68), fire wall (66), panel (67), and end panels (72 thru 75) from frame (76).

e. Refer to paragraph 13-22 for disassembly procedures for the control box.

### 13-4. CLEANING

a. Clean electrical components with a clean lint-free cloth moistened with an approved cleaning solvent and dry thoroughly.

b. Clean metal parts in an approved cleaning solvent and dry thoroughly.

### 13-5. INSPECTION AND TEST.

a. Inspect parts for cracks, dents, and distortion.

b. Inspect threads for damage.

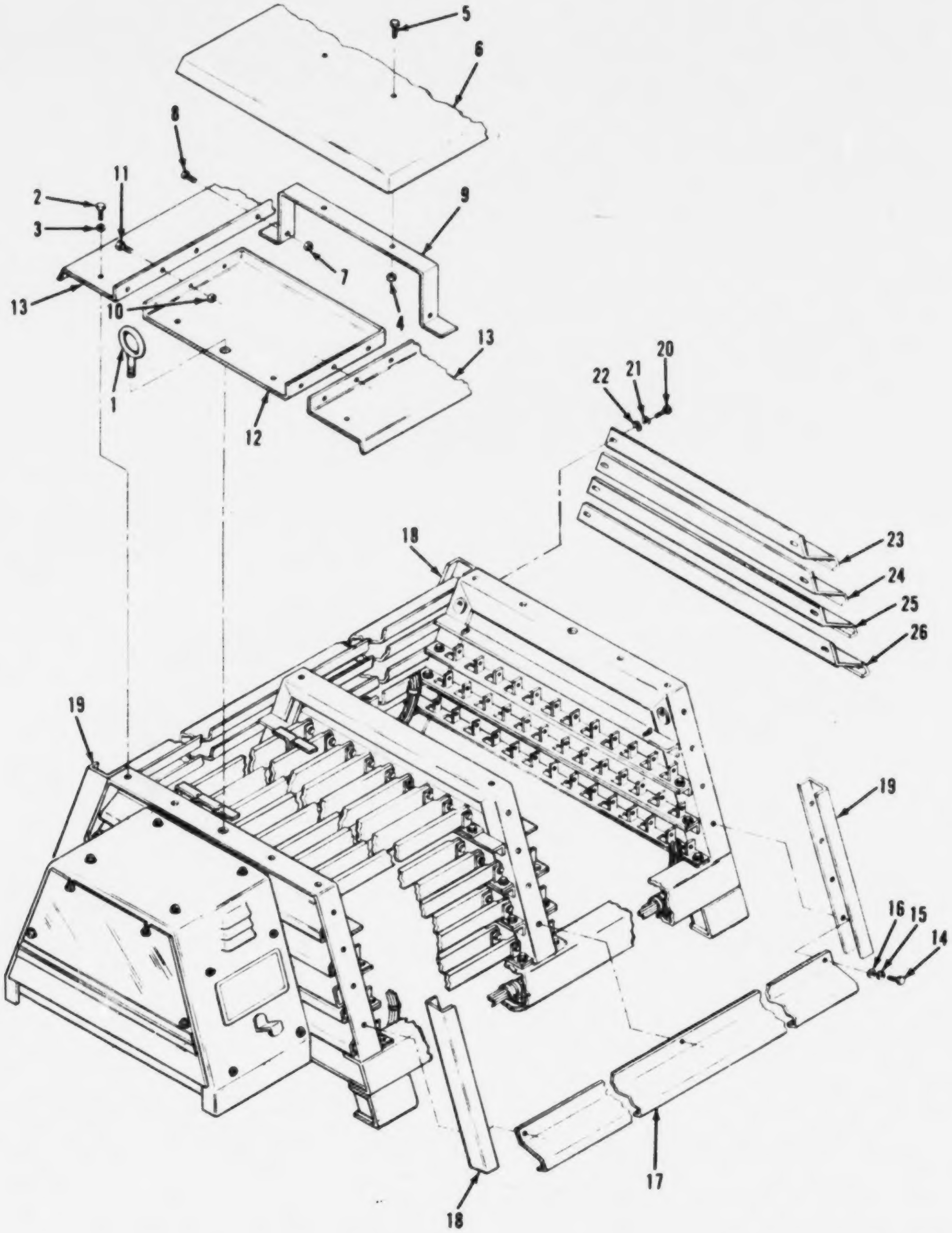
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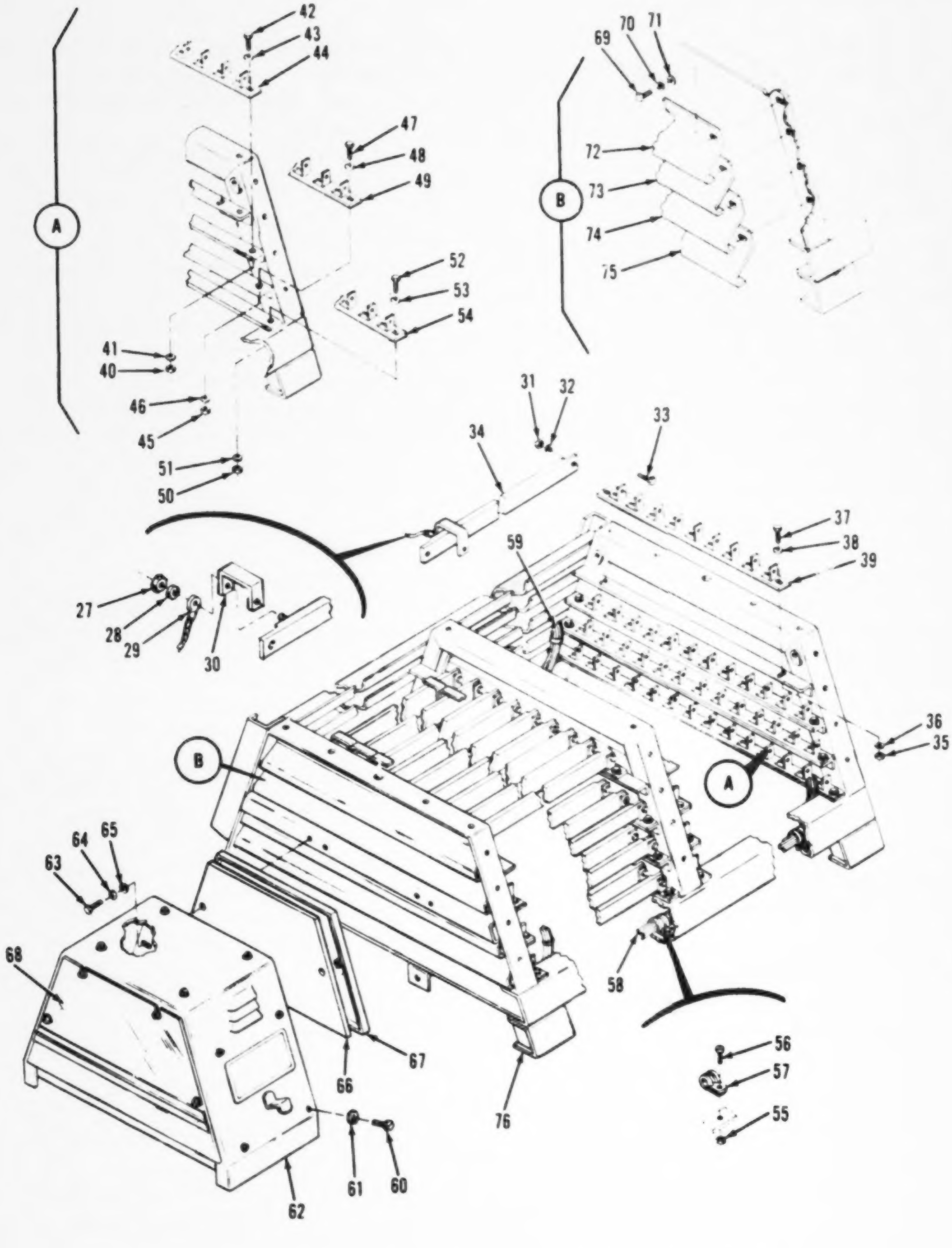
Figure 13-1. Dummy load kit, exploded view (sheet 1 of 2)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34
37
38
39
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67
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61
60
62

Figure 13-1. Dummy load kit, exploded view (sheet 2 of 2)

Legend to figure 13-1.

1. Eye bolt (2)
2. Screw (6)
3. Lock washer (6)
4. Nut (8)
5. Screw (8)
6. Cover
7. Nut (8)
8. Screw (8)
9. Bracket (4)
10. Nut (12)
11. Screw (12)
12. Splash pan (2)
13. Side rail (2)
14. Screw (24)
15. Lock washer (24)
16. Washer (24)
17. Side panel (8)
18. Channel (2)
19. Channel (2)
20. Screw (8)
21. Lock washer (8)
22. Washer (8)
23. End panel
24. End panel
25. End panel
26. End panel
27. Nut (192)
28. Washer (192)
29. Lead (15)
30. Strap (140)
31. Nut (192)
32. Lock washer (192)
33. Screw (192)
34. Heater Element (96)
35. Nut (4)
36. Washer (4)
37. Screw (4)
38. Washer (4)
39. Resistor bracket (4)
40. Nut (4)
41. Washer (4)
42. Screw (4)
43. Washer (4)
44. Resistor bracket (4)
45. Nut (4)
46. Washer (4)
47. Screw (4)
48. Washer (4)
49. Resistor bracket (4)
50. Nut (4)
51. Washer (4)
52. Screw (4)
53. Washer (4)
54. Resistor bracket (4)
55. Nut (6)
56. Screw (6)
57. Clamp (6)
58. Wire harness
59. Wire harness
60. Screw (12)
61. Lock washer (12)
62. Control box assembly cover
63. Screw (4)
64. Lock washer (4)
65. Washer (4)
66. Fire wall
67. Panel
68. Control box
69. Screw (8)
70. Lock washer (8)
71. Washer (8)
72. End panel
73. End panel
74. End panel
75. End panel
76. Frame

NOTE

Dummy load kit wiring diagram is contained in the Operator and Organizational Maintenance Manual.

c. Refer to figure 13-2 and 13-3 and check each harness wire for continuity. Check harness wires for loose terminal lugs and defective installation.

d. A quick test of heater elements may be accomplished without disassembly of dummy load bank. Measure resistance between terminal points 1, 7, 13, 19, 25, 31, 37, 43, 49, 55, 61 and 67 to neutral lead LO on dummy load bank terminal board. Resistance valves should be approximately (1.75 ohms 120/208 voltage connection or (7 ohms 240/416 voltage connections). Refer to figure 1-23.

WARNING

Do not touch heater elements during test and permit elements to cool prior to removing test equipment.

e. Test resistance of each heater element, resistance should be 11 to 14 ohms. Test each heater element by connecting a 120 VAC; 50, 60, or 400 hertz power supply and a 0 - 10 ampere AC ammeter to heater element terminals. Turn on power supply, heater element should draw 8.3 amperes. Remove test equipment.

f. Inspect fire wall for deterioration, cracks, and damaged ends.

g. Inspect paint for deterioration, cracks, and damaged ends.

## 13-6. REPAIR.

a. Repair cracks by welding.

b. Straighten dented or distended parts using suitable tools.

c. Remove damaged paint. Blend in edges, prime, and paint damaged areas.

d. Repair damaged harnesses as specified in figure 13-2 or 13-3.

## 13-7. WIRING HARNESS REBUILD.

a. Rebuild dummy load kit right side wiring harness as specified in figure 13-2.

b. Rebuild dummy load kit left side wiring harness as specified in figure 13-3.

## 13-8. REASSEMBLY.

Refer to figure 13-1 and reassemble dummy load kit in the reverse order of index numbers assigned. Pay particular attention to the following:

a. Install end panels (72 thru 75) on frame (76).

b. Position wire harnesses (58 and 59) on frame (76) and secure with clamps (57) screws (56) and nuts (55).

c. Reassemble control box as specified in paragraph 13-27.

d. Install control box (68), fire wall (66), and panel (67) on frame (76). Connect wire harnesses (58 and 59) to control box components. Install control box cover (62) on control box assembly (68).

NOTE

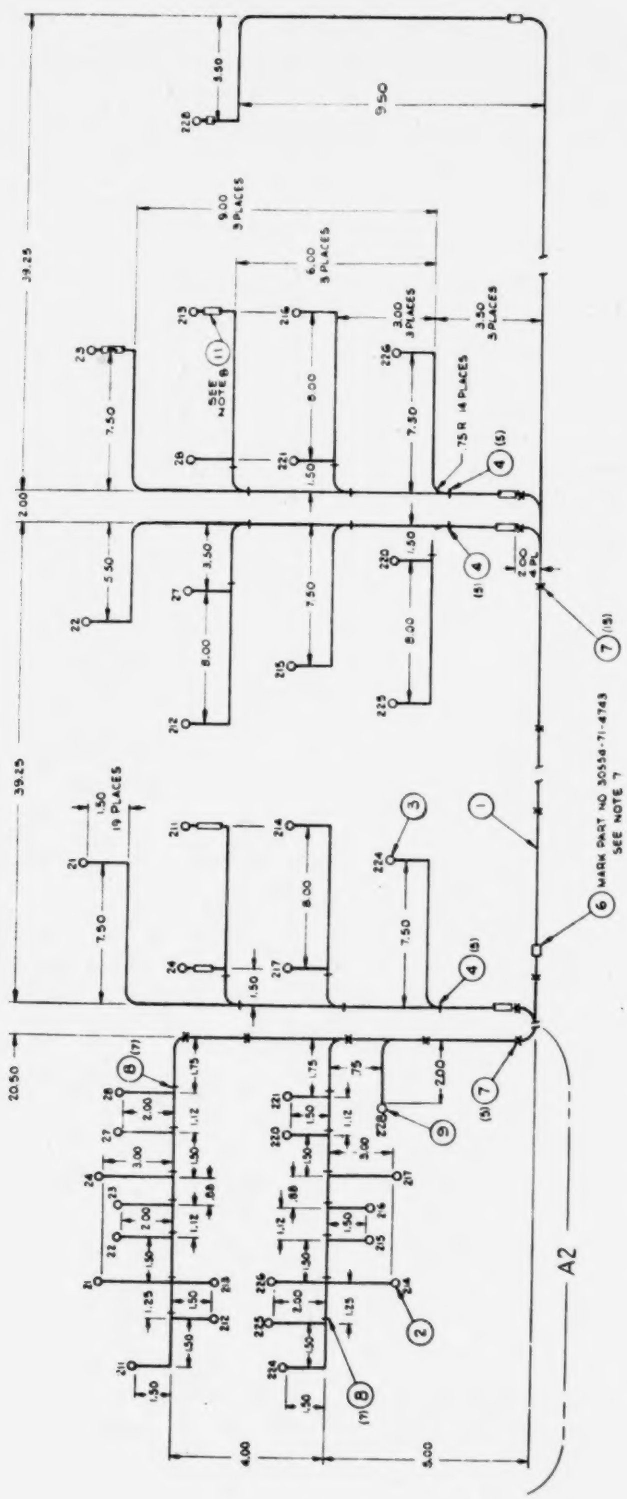
Dummy load kit wiring diagram is contained in the Operator and Organizational Maintenance Manual.

e. Install heater elements (34) and leads (29). Leave screws (33) at center frame loose to permit expansion and travel of heater elements (34). Check wiring for proper connection.

f. Install end panels (23 thru 26), channels (18 and 19), side panels (17), and cover assembly.

## 13-9. INSTALLATION.

Refer to Operator and Organizational Maintenance Manual and install dummy load kit.


39.25
39.25
20.50
2.00
9.50
5.50
9.00 3 PLACES
6.00 3 PLACES
3.00 3 PLACES
3.50 3 PLACES
.75 R 14 PLACES
1.50 19 PLACES
2.00 4 PL
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MARK PART NO 30554-71-4743 SEE NOTE 7
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A2
4.00
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228

Figure 13-2. Dummy load kit right side wiring harness (sheet 1 of 2)

| WIRE NO. | WIRE |  | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG (REF) |
|---|---|---|---|---|---|---|---|
|  | COLOR | GAUGE |  |  |  |  |  |
| 31 | WHITE | #10 GA | A2-35 | 2 | R10-1 | 3 | 69.00 |
| 33 | WHITE | #10 GA | A2-29 | 2 | R11-2 | 3 | 107.00 |
| 35 | WHITE | #10 GA | A2-30 | 2 | R14-1 | 3 | 108.00 |
| 34 | WHITE | #10 GA | A2-49 | 2 | R18-1 | 3 | 66.00 |
| 37 | WHITE | #10 GA | A2-53 | 2 | R19-2 | 3 | 106.00 |
| 38 | WHITE | #10 GA | A2-54 | 2 | R22-1 | 3 | 106.00 |
| 311 | WHITE | #10 GA | A2-7 | 2 | R26-1 | 3 | 64.00 |
| 312 | WHITE | #10 GA | A2-11 | 2 | R27-2 | 3 | 103.00 |
| 313 | WHITE | #10 GA | A2-12 | 2 | R30-1 | 3 | 105.00 |
| 314 | WHITE | #10 GA | A2-37 | 2 | R58-1 | 3 | 59.00 |
| 315 | WHITE | #10 GA | A2-41 | 2 | R59-2 | 3 | 96.00 |
| 316 | WHITE | #10 GA | A2-42 | 2 | R63-1 | 3 | 99.00 |
| 317 | WHITE | #10 GA | A2-61 | 2 | R66-1 | 3 | 59.00 |
| 320 | WHITE | #10 GA | A2-65 | 2 | R67-2 | 3 | 99.00 |
| 321 | WHITE | #10 GA | A2-66 | 2 | R70-1 | 3 | 101.00 |
| 324 | WHITE | #10 GA | A2-19 | 2 | R74-1 | 3 | 47.00 |
| 325 | WHITE | #10 GA | A2-23 | 2 | R75-2 | 3 | 92.00 |
| 326 | WHITE | #10 GA | A2-24 | 2 | R78-1 | 3 | 91.00 |
| 328 | WHITE | #10 GA | A2-LO | 9 | R86-2 | 3 | 129.00 |

| WIRE LENGTH TOLERANCES |  |  |
|---|---|---|
| OVER | INCL. | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 12 |  |  |  |  |  |  |  |
| 11 |  | B | 71-4927 | A/R | SLEEVING, FIBERGLASS |  |  |
| 10 |  |  |  |  |  |  |  |
| 9 |  |  | MS25036-158 | 1 | TERMINAL, LUG, CRIMP STYLE |  |  |
| 8 |  |  | MS3367-4-9 | 14 | STRAP, TIEDOWN |  | NYLON |
| 7 |  |  | MS3367-1-9 | 20 | STRAP, TIEDOWN |  | NYLON |
| 6 |  |  | MS39020-1 | 1 | BAND, MARKER |  | AL ALY |
| 5 |  |  |  |  |  |  |  |
| 4 |  |  | MS39020-4 | 15 | BAND |  | AL ALY |
| 3 |  |  | MS20659-105 | 19 | TERMINAL, LUG, CRIMP STYLE |  |  |
| 2 |  |  | MS25036-113 | 18 | TERMINAL, LUG, CRIMP STYLE |  |  |
| 1 |  |  | TYPE-E-10 | A/R | WIRE, ELECTRICAL, TEFLON | MIL-W-16878/4A |  |

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH.
2. CABLE STRAPS, FIND NO. 4, 7 & 8, SHALL BE SPACED AT APPROX. 3.00 INCHES APART UNLESS OTHERWISE SPECIFIED.
3. FOR SCHEMATIC DIAGRAM, SEE DRAWING NO. 71-4733
4. FOR WIRING DIAGRAM, SEE DRAWING NO. 71-4760
5. VENDOR ITEM, SEE SOURCE/SPEC CONTROL DWG.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.
7. EACH WIRE TO BE MARKED WITH WIRE NUMBER AS SPECIFIED IN WIRE TABLE. HOT STAMP WIRE NUMBER IN ACCORDANCE WITH MIL-M-81594, TYPE XIII
8. EXCEPT FOR SECTION A-2 SLEEVE ALL LEADS FROM LUG END FIND NO 3, TO MAIN HARNESS BREAKOUTS, WITH FIND NO 11, PRIOR TO INSTALLING TERMINAL LUGS.

Figure 13-2. Dummy load kit right side wiring harness (sheet 2 of 2)

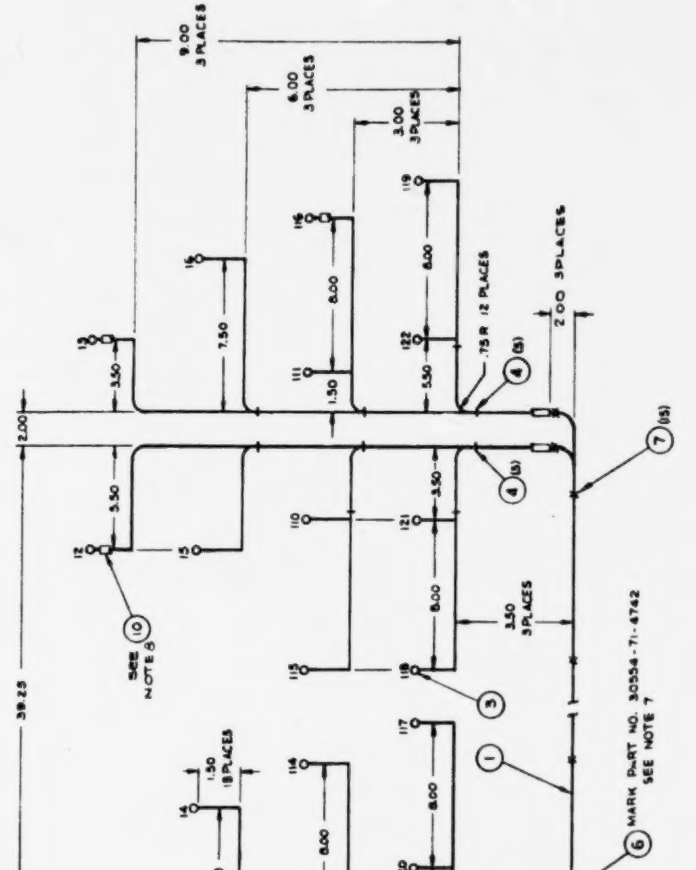

9.00 3 PLACES
6.00 3 PLACES
3.00 3 PLACES
.75 R 12 PLACES
2.00 3 PLACES
39.25
20.50
2.00
SEE NOTE 8
MARK PART NO. 30554-71-4742 SEE NOTE 7
3.50 3 PLACES
1.50 18 PLACES
4.00
6.00
A2
REF

Figure 13-3. Dummy load kit (left side) wiring harness (sheet 1 of 2)

| WIRE NO. | WIRE |  | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG (REF) |
|---|---|---|---|---|---|---|---|
|  | COLOR | GAUGE |  |  |  |  |  |
| 11 | WHITE | #10 GA | A2-1 | 2 | R2-1 | 3 | 68.00 |
| 12 | WHITE | #10 GA | A2-5 | 2 | R3-1 | 3 | 106.00 |
| 13 | WHITE | #10 GA | A2-6 | 2 | R6-1 | 3 | 110.00 |
| 14 | WHITE | #10 GA | A2-31 | 2 | R34-1 | 3 | 62.00 |
| 15 | WHITE | #10 GA | A2-35 | 2 | R35-2 | 3 | 102.00 |
| 16 | WHITE | #10 GA | A2-36 | 2 | R38-2 | 3 | 101.00 |
| 17 | WHITE | #10 GA | A2-55 | 2 | R42-1 | 3 | 54.00 |
| 110 | WHITE | #10 GA | A2-59 | 2 | R43-2 | 3 | 103.00 |
| 111 | WHITE | #10 GA | A2-60 | 2 | R46-1 | 3 | 96.00 |
| 114 | WHITE | #10 GA | A2-13 | 2 | R50-1 | 3 | 60.00 |
| 115 | WHITE | #10 GA | A2-17 | 2 | R51-2 | 3 | 100.00 |
| 116 | WHITE | #10 GA | A2-18 | 2 | R54-1 | 3 | 102.00 |
| 117 | WHITE | #10 GA | A2-43 | 2 | R82-1 | 3 | 53.00 |
| 118 | WHITE | #10 GA | A2-47 | 2 | R83-2 | 3 | 86.00 |
| 119 | WHITE | #10 GA | A2-48 | 2 | R86-1 | 3 | 98.00 |
| 120 | WHITE | #10 GA | A2-67 | 2 | R90-1 | 3 | 47.00 |
| 121 | WHITE | #10 GA | A2-71 | 2 | R91-2 | 3 | 90.00 |
| 122 | WHITE | #10 GA | A2-72 | 2 | R94-1 | 3 | 91.00 |

| WIRE LENGTH TOLERANCES |  |  |
|---|---|---|
| OVER | INCL | TOL ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .38 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 11 |  |  |  |  |  |  |  |
| 10 |  | B | 71-4927 | A/R | SLEEVING, FIBERGLASS |  |  |
| 9 |  |  |  |  |  |  |  |
| 8 |  |  | MS3367-4-9 | 16 | STRAP, TIEDOWN |  | NYLON |
| 7 |  |  | MS3367-1-9 | 20 | STRAP, TIEDOWN |  | NYLON |
| 6 |  |  | MS39020-1 | 1 | BAND, MARKER |  | AL ALY |
| 5 |  |  |  |  |  |  |  |
| 4 |  |  | MS39020-4 | 15 | BAND |  | AL ALY |
| 3 |  |  | MS20659-105 | 18 | TERMINAL, LUG, CRIMP STYLE |  |  |
| 2 |  |  | MS25036-113 | 18 | TERMINAL, LUG, CRIMP STYLE |  |  |
| 1 |  |  | TYPE-E-10 | A/R | WIRE, ELECTRICAL, TEFLON | MIL-W-16878/4A |  |

NOTES:

1. ALL CONDUCTORS ENDS TO BE STRIPPED BACK .25 INCH.
2. CABLE STRAPS, FIND NO. 4, 7 & 8, SHALL BE SPACED AT APPROX. 3.00 INCHES APART UNLESS OTHERWISE SPECIFIED.
3. FOR SCHEMATIC DIAGRAM, SEE DRAWING NO. 71-4733
4. FOR WIRING DIAGRAM, SEE DRAWING NO. 71-4760
5. VENDOR ITEM, SEE SOURCE/SPEC CONTROL DRAWING
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.
7. EACH WIRE TO BE MARKED WITH WIRE NUMBER AS SPECIFIED IN WIRE TABLE. HOT STAMP WIRE NUMBER IN ACCORDANCE WITH MIL-M-81594, TYPE XIII
8. EXCEPT FOR SECTION A2, SLEEVE ALL LEADS FROM LUG END, FIND NO. 3 TO MAIN HARNESS BREAKOUTS, WITH FIND NO. 10, PRIOR TO INSTALLING TERMINAL LUG

Figure 13-3. Dummy load kit (left side) wiring harness (sheet 2 of 2)

## Section II. CONTROL BOX

### 13-10. GENERAL.

a. Control Box. The control box contains the operating controls of the dummy load kit. The box incorporates a harness, load selector switch, load removal switch, voltage change terminal board, load dumping relay, transformer, diodes, resistors, capacitors, relay, transistors and contactors.

b. Load Dumping Relay (K5). The relay contains controls necessary to automatically remove dummy load kit from operation when the automatic load removal switch is positioned to ON. With the switch in the ON position the dummy load kit is removed from operation when the generator set load exceeds 50 percent. After automatic load removal the relay must be manually reset by positioning automatic load removal switch to BY-PASS RESET.

### 13-11. LOAD DUMPING RELAY (K5).

13-12. REMOVAL. Refer to figure 13-4 and remove the load dumping relay as follows:

a. Disconnect cover (11) from frame (91) by removing screws (9) and washers (10).

b. Tag and disconnect harness (51) wires from load dumping relay (45).

c. Disconnect load dumping relay (45) by removing screws (44).

13-13. TEST AND BENCH TEST.

a. Connect test equipment to the load dumping relay as illustrated in figure 13-5.

b. Perform test specified in table 13-1.

13-14. DISASSEMBLY. Refer to figure 13-6 and disassemble load dumping relay to the extent necessary to effect repair as follows:

a. Remove relay, relay socket, and terminal strip by removing screws, washers, and nuts.

b. Unsolder components from their connection points exercising care not to apply excessive heat to components.

13-15. CLEANING. Clean parts with a clean lint free cloth moistened in an approved cleaning solvent and dry thoroughly.

13-16. INSPECTION.

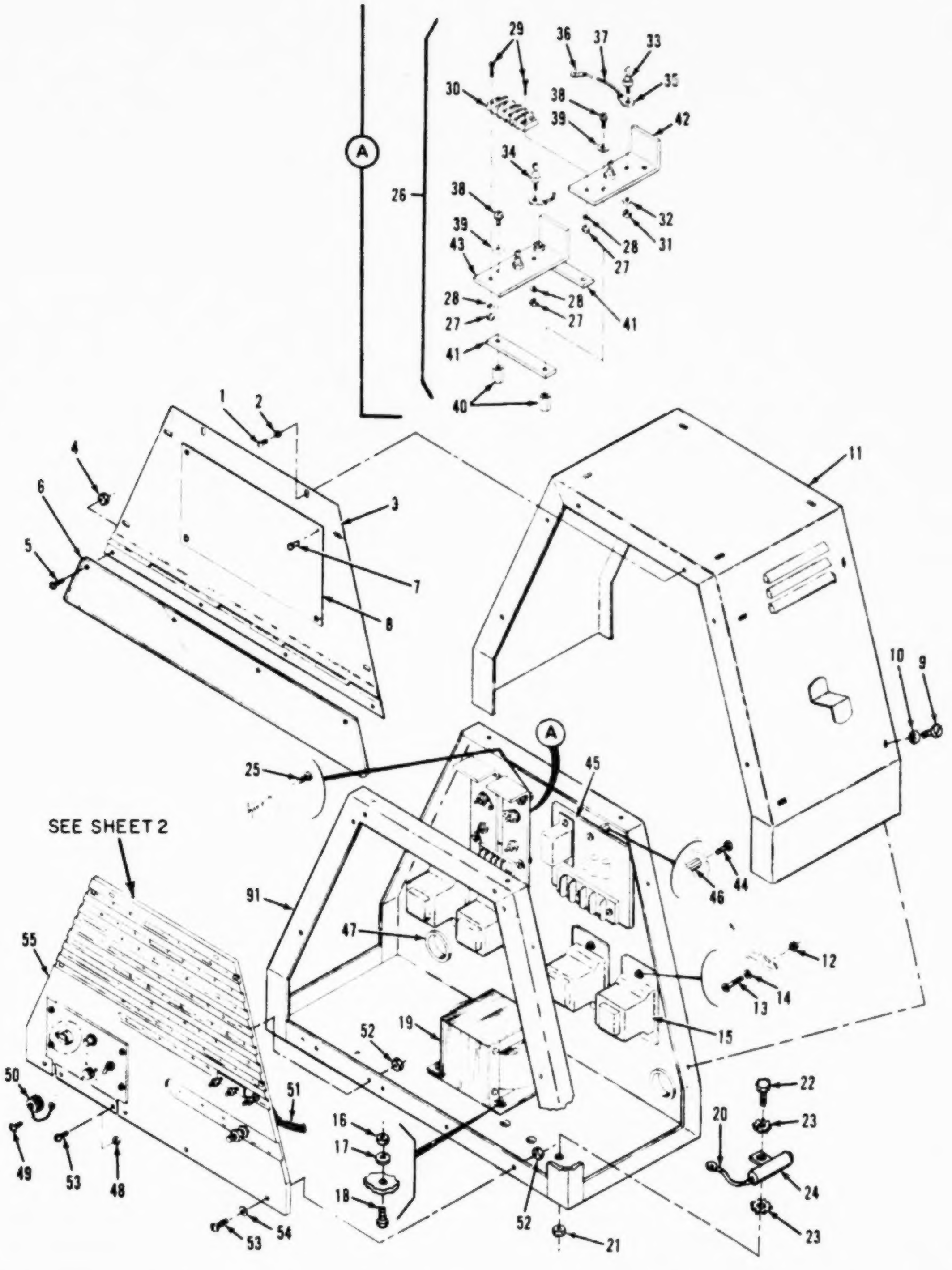
a. Inspect component side of circuit board for damage, burns, discolored areas, and signs of overheating. Check components for security.

b. Inspect printed circuits of board for breaks and damage.

13-17. REPAIR. Repair printed circuits by soldering a jumper wire accross defective area exercising care not to apply excessive heat to components. Make sure solder joints do not project more than 0.094 inch beyond surface of board.

13-18. REASSEMBLY. Refer to figure 13-6. and reassembly load dumping relay as follows:

a. Solder components to their connection points excercising care not to apply excessive heat to components.


A
29
36
37
33
35
30
38
42
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26
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43
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28
28
27
27
41
41
40
1
2
11
4
6
3
5
7
8
10
9
A
25
45
SEE SHEET 2
44
46
91
55
47
12
13
14
19
52
15
22
50
51
16
17
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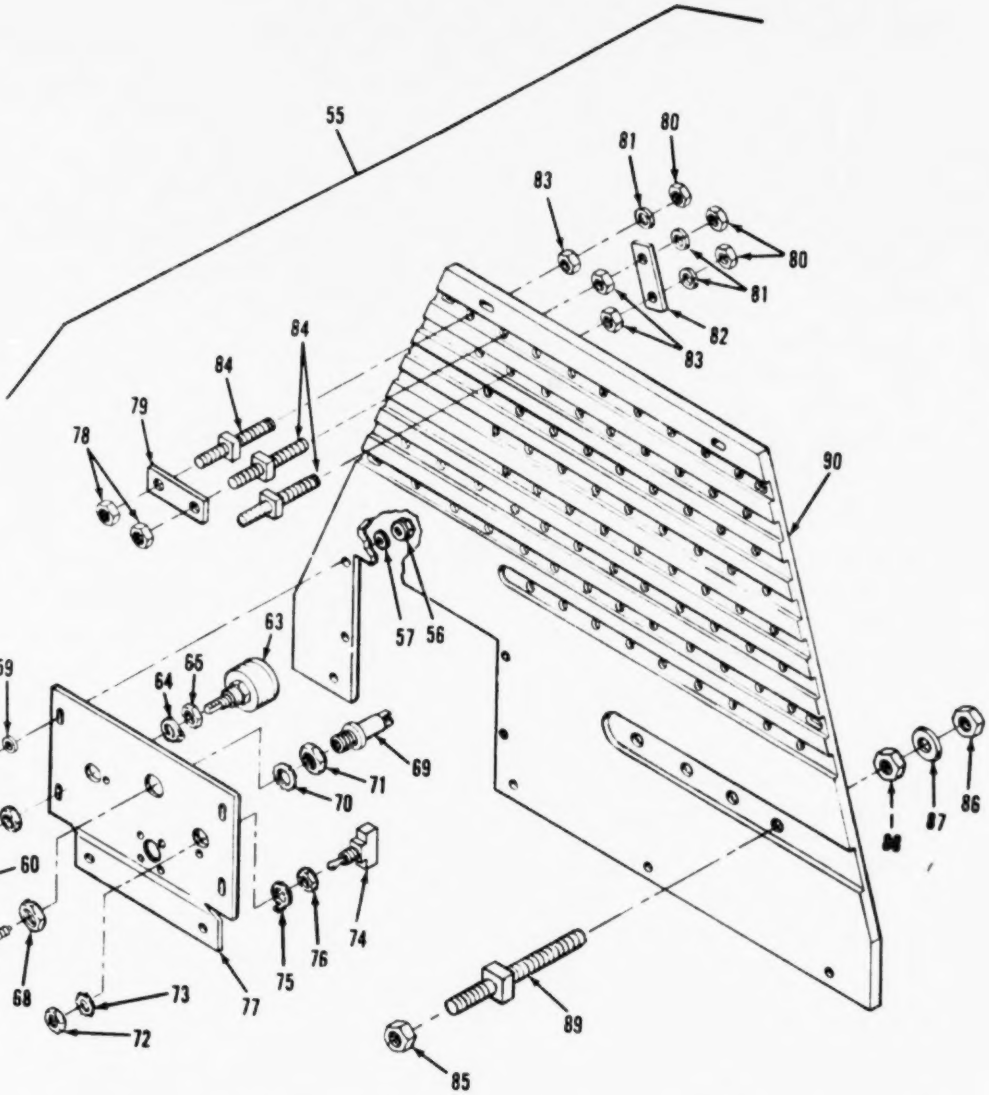
23

Figure 13-4. Dummy load kit control box, exploded view (sheet 1 of 2)


55
80
81
83
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81
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84
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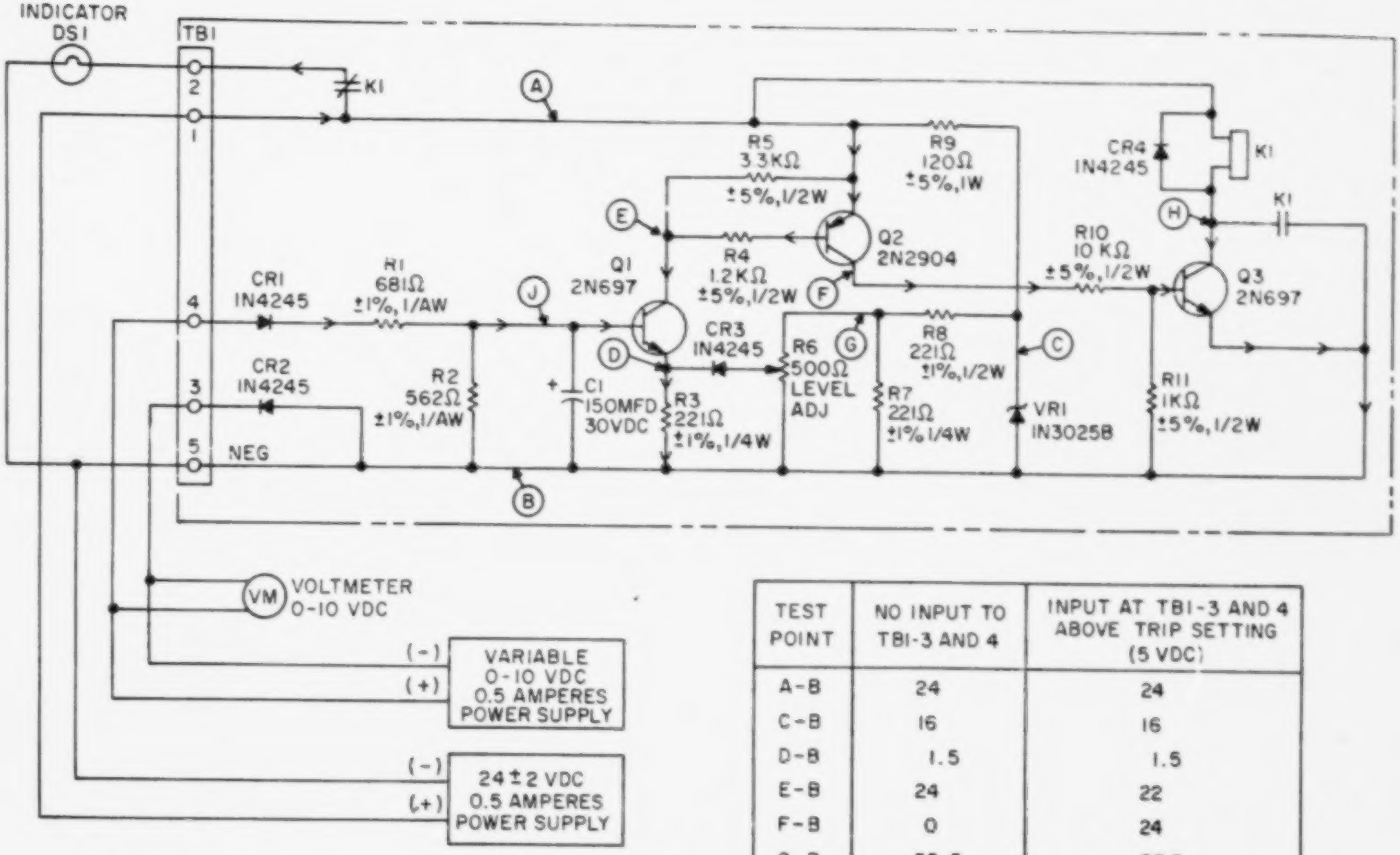
67
73
72
89
85

Figure 13-4. Dummy load kit control box, exploded view (sheet 2 of 2)

Legend to figure 13-4:

1. Screw (6)
2. Washer (6)
3. Upper panel
4. Nut (4)
5. Screw (3)
6. Lower panel
7. Rivet (4)
8. Instruction plate
9. Screw (12)
10. Washer (12)
11. Cover
12. Nut (12)
13. Screw (12)
14. Washer (12)
15. Contactor (4)
16. Nut (4)
17. Washer (4)
18. Screw (4)
19. Transformer
20. Lead (3)
21. Nut (3)
22. Screw (3)
23. Lock washer (6)
24. Capacitor (3)
25. Screw (4)
26. Bridge rectifier assembly
27. Nut (2)
28. Washer (2)
29. Screw (2)
30. Terminal board
31. Nut (4)
32. Washer (4)
33. Diode (2)
34. Diode (2)
35. Terminal lug (2)
36. Terminal lug (4)
37. Lead (4)
38. Screw (4)
39. Washer (4)
40. Spacer (4)
41. Insulated plate (2)
42. Heatshield
43. Heatshield
44. Screw (3)
45. Load dumping relay K5
46. Spacer (3)
47. Grommet (2)
48. Nut (4)
49. Screw (4)
50. Cover and chain
51. Harness
52. Nut (14)
53. Screw (10)
54. Washer (10)
55. Reconnection board assembly
56. Nut (4)
57. Washer (4)
58. Screw (4)
59. Washer (4)
60. Setscrew
61. Knob
62. Nut
63. Load selector switch
64. Tab waste
65. Nut
66. Lens
67. Lamp
68. Nut
69. Light
70. Washer
71. Nut
72. Nut
73. Washer
74. Automatic load removal switch
75. Tab washer
76. Nut
77. Control board panel
78. Nut (52)
79. Link (26)
80. Nut (78)
81. Lock washer (78)
82. Rear link (13)
83. Nut (78)
84. Terminal stud (78)
85. Nut (4)
86. Nut (4)
87. Washer (4)
88. Nut (4)
89. Load stud (4)
90. Terminal board
91. Frame


INDICATOR
DS1
TB1
2
1
4
3
5
NEG
K1
A
B
C
D
E
F
G
H
J
CR1
1N4245
R1
681Ω
±1%, 1/AW
CR2
1N4245
R2
562Ω
±1%, 1/AW
C1
150MFD
30VDC
Q1
2N697
CR3
1N4245
R3
221Ω
±1%, 1/4W
R4
1.2KΩ
±5%, 1/2W
R5
3.3KΩ
±5%, 1/2W
Q2
2N2904
R6
500Ω
LEVEL
ADJ
R7
221Ω
±1% 1/4W
R8
221Ω
±1%, 1/2W
R9
120Ω
±5%, 1W
VR1
1N3025B
R10
10 KΩ
±5%, 1/2W
Q3
2N697
R11
1KΩ
±5%, 1/2W
CR4
1N4245
K1
K1
VM
VOLTMETER
0-10 VDC
(-)
(+)
VARIABLE
0-10 VDC
0.5 AMPERES
POWER SUPPLY
(-)
(+)
24 ± 2 VDC
0.5 AMPERES
POWER SUPPLY

| TEST POINT | NO INPUT TO TB1-3 AND 4 | INPUT AT TB1-3 AND 4 ABOVE TRIP SETTING (5 VDC) |
|---|---|---|
| A-B | 24 | 24 |
| C-B | 16 | 16 |
| D-B | 1.5 | 1.5 |
| E-B | 24 | 22 |
| F-B | 0 | 24 |
| G-B | 55.5 | 55.5 |
| H-B | 24 | 0 |
| J-B | 0 | 2.0 |
| ALL READINGS ± 20% | | |

Figure 13-5. Dummy load kit load dumping relay (K5), test setup

Table 13-1. Dummy Load Kit Load Dumping Relay (K5) Procedural Analysis

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| NOTE<br>Figure 1-31 is the dummy load kit schematic | | | | |
| 1. | Turn on 24 VDC power supply. | DS 1 should be illuminated. | Defective relay K1. | Remove relay and test as specified in figure 6-5. |
| 2. | Adjust variable 0-10 VDC power supply to read 5.2 VDC ± 5 per cent on test volt meter. | DS 1 should be extinguished. | Variable resistor R6 adjusted incorrectly. | Adjust R6 until relay K1 energizes and DS1 extinguishes without changing voltage across TB1 3 and 4. |
| | NOTE<br>Maintain 5.2 VDC ± 5 percent on test volt meter through out remaining tests. | NOTE<br>Voltage readings should be ± 20 per cent through out remaining tests. | Defective relay K1. | Remove relay and test as specified in figure 6-5. |
| | | | Defective printed circuit board component. | Proceed with steps 3 to 7. |
| 3. | Measure voltage between test points J and B. | Voltage should be 2 VDC. | Defective diode CR1 or CR2; resistor R1 or R2; compacitor C1. | Check components for proper rating. |

Table 13-1. Dummy Load Kit Load Dumping Relay (K5) Procedural Analysis (Cont)

| STEP | TEST CONDITION | REQUIRED RESULT | PROBABLE CAUSE FOR IMPROPER RESULT | CHECK OUT PROCEDURE |
|---|---|---|---|---|
| 4. | Measure voltage between test points D and B. | Voltage should be 1.5 VDC. | Defective resistor R9, R8 R7 or R3; variable resistor R6; diode CR3; zener diode VR1. | Check components for proper rating. |
| 5. | Measure voltage between test points E and B. | Voltage should be 22 VDC. | Defective resistor R5. | Check resistor using ohmmeter. |
| | | | Defective transistor Q1. | Check transistor with a transistor checker or multimeter. |
| 6. | Measure voltage between test points F and B. | Voltage should be 24 VDC. | Defective transistor Q2. | Check transistor with a transistor checker or multimeter. |
| | | | Defective resistor R10. | Check resistor with a multimeter. |
| 7. | Measure voltage between test points H and B. | Voltage should be zero. | Defective transistor Q3. | Check transistor with a transistor checker or multi-meter. |
| | | | Defective resistor R10 or R11. | Check resistors with ohmmeter. |

b. Secure relay, relay socket, and terminal strip in position and secure with screws, washers, and nuts.

c. After replacement of components on the printed circuit board, coat the board with protective coating, conforming to Military Specification MIL-I-46058, grade S, type PUR, 0.0050 minimum thickness. The coating shall be applied so that it anchors the components to the board. Terminals utilized for connection to external circuits shall not be coated.

13-19. INSTALLATION. Refer to figure 13-4 and install the load dumping relay as follows:

a. Connect load dumping relay (45) to frame (91) and secure with screws (44).

NOTE

Dummy load kit wiring diagrams is contained in the Operator and Organizational Maintenance Manual.

b. Connect electrical wiring to relay. Check wiring for proper connection.

c. Install cover (11) and secure with screws (9) and washers (10).

## 13-20. CONTROL BOX.

13-21. REMOVAL. Refer to figure 13-1 and remove control box as follows:

WARNING

Make sure dummy load kit is not connected to generator set prior to performing maintenance.

a. Disconnect cover (57) by removing serews (54), and washers (55 and 56).

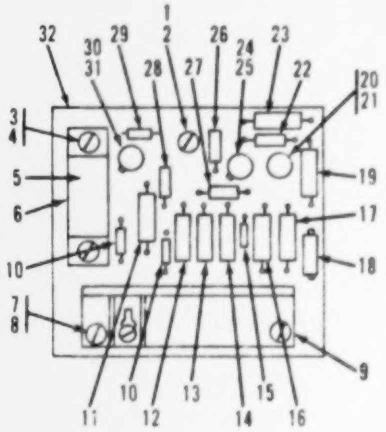


Figure 13-6. Dummy load kits load dumping relay (K5).

Legend to figure 13-6.

1. Screw
2. Spacer
3. Screw (2)
4. Lock washer (2)
5. Relay
6. Relay socket
7. Screw (2)
8. Spacer (2)
9. Terminal board
10. Diode (2)
11. Resistor
12. Capacitor
13. Resistor
14. Resistor
15. Diode
16. Zener diode
17. Resistor
18. Variable resistor
19. Resistor
20. Transistor
21. Transistor pad
22. Resistor
23. Resistor
24. Transistor
25. Transistor pad
26. Resistor
27. Resistor
28. Resistor
29. Diode
30. Transistor
31. Transistor pad
32. Board

b. Tag and disconnect frame harness wires from control box components.

c. Disconnect control box (63) from frame (70) by removing screws (58) and washers (59 and 60).

13-22. DISASSEMBLY. Refer to figure 13-4 and disassemble control box in the order of index number assigned. Pay particular attention to the following.

NOTE

Disassemble control box only to the extent necessary to effect repair.

a. Remove cover (11). Tag and disconnect harness (51) wires from components.

b. Disassemble load dumping relay or specified in paragraph 13-14, only after performing test specified in paragraph 13-13.

c. To remove leads (20) from capacitors. (24), remove screws and washers securing leads to capacitor terminal.

d. Tag lead (37) with location prior to removal to insure proper reassembly.

e. Note position of rear links (82) prior to removal to insure proper reassembly.

13-23. CLEANING.

a. Clean electrical components with a clean lint-free cloth moistened in an approved cleaning solvent and dry thoroughly.

b. Clean metal parts in an approved cleaning solvent and dry thoroughly.

13-24. INSPECTION.

a. Inspect harness wires for defective or loose terminal lugs and defective insulation. Check each wire for continuity, refer to figure 13-7. Check connects for bent, loose, or missing pins and for shorts from case to pins and pins to surrounding pins.

NOTE

Figure 1-31 is the dummy load kit schematic.

b. Check switches and light assembly for continuity.

13-25. TEST.

a. Test for continuity between contactors K1, K2, K3, and K4 terminals L1 to T1, L2 to T2, and L3 to T3; there should not be continuity. Connect a 24 VDC ± 4 volt, 5 ampere power supply and 0 - 5 ampere ammeter to contactor terminals C1 and C3. Turn on power supply and observe ammeter. Ammeter should indicate 4.5 amperes pull-in current and 0.9 amperes holding current. Check for continuity between terminals L1 to T1, L2 to T2, and L3 to T3; there should be continuity. Turn off power supply.

b. Test resistance of transformer windings. Check between terminals 1 and 2, 3 and 4, and 5 and 6; resistance should be 6.5, 7, and 0.06 ohms respectively. Check insulation resistance using a 500 volt megger, resistance should be greater than 1 megohm. Connect a 120 VAC, 50/60 hertz 0.5 ampere power supply to terminals 1 and 2 of transformer. Connect a 0 - 3 ampere ammeter in series with power supply and terminal 1. Connect a 0 - 50 VAC voltmeter accross transformer terminals 5 and 6. Turn on power supply, ammeter should indicate less than 0.05 amperes and voltmeter should indicate 35 volts. Connect power supply and ammeter to terminals 3 and 4 with ammeter in series with terminal 3. Turn on power supply, ammeter should indicate less than 0.05 amperes and voltmeter should indicate 35 volts. Remove test equipment from transformer.

c. Test forward and reverse resistance of diodes. Measured from anode (+)

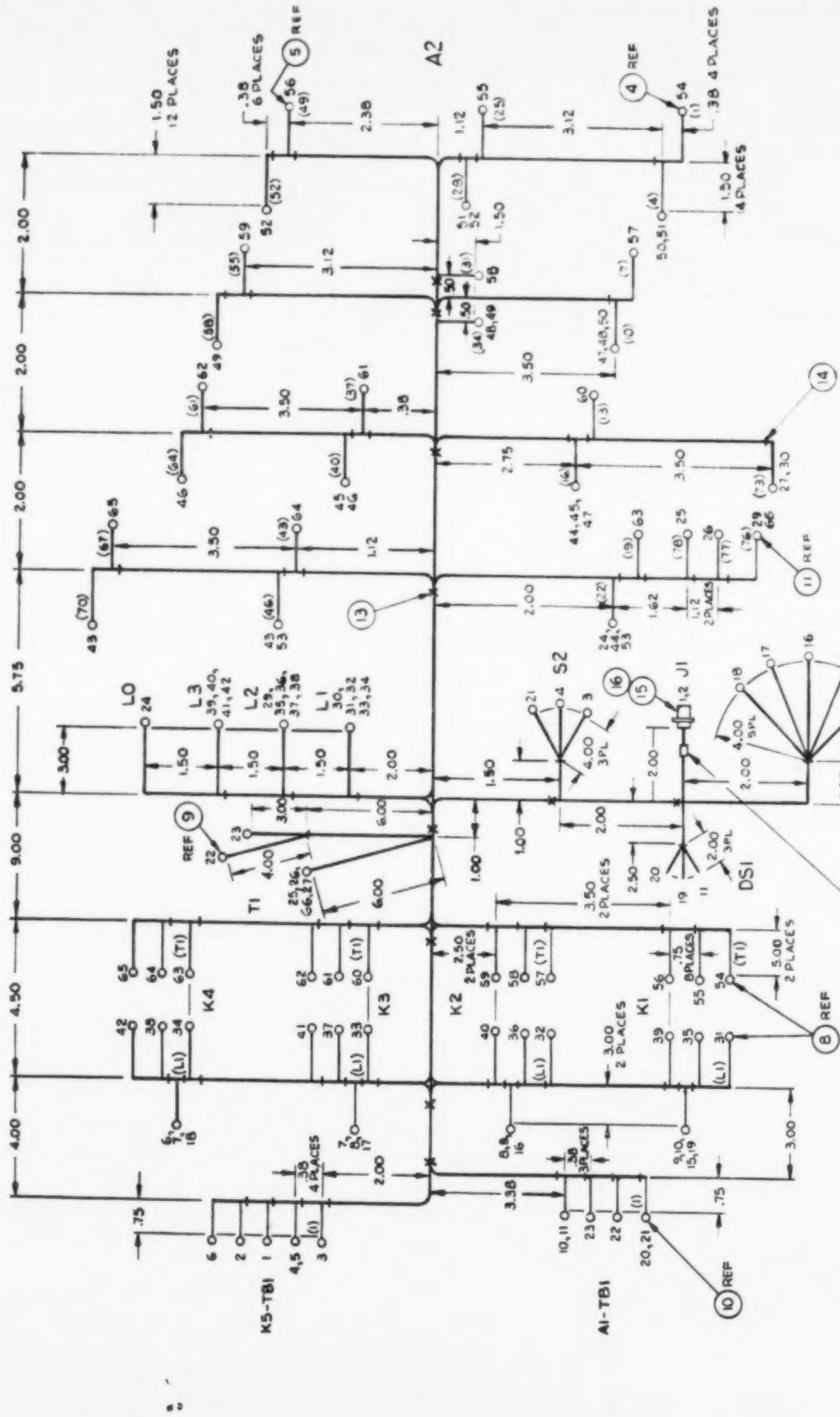

A2
K5-TB1
A1-TB1
K1
K2
K3
K4
T1
L0
L1
L2
L3
S1
S2
J1
DS1
MARK PART NO.
30554-71-4662
SEE NOTE 5
REF

Figure 13-7. Dummy load kit control box harness (sheet 1 of 3)

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 1 | BLACK | V340A16 | J1-A | — | K5TB1-3 | 10 | 31.00 |
| 2 | | V341A16 | J1-B | — | K5TB1-4 | 10 | 31.00 |
| 3 | | P342A16 | K5TB1-1 | 10 | S2-1 | 10 | 31.00 |
| 4 | | P343A16 | K5TB1-2 | 10 | S2-3 | 10 | 31.00 |
| 5 | | P343D16 | K5TB1-2 | 10 | S1-11 | 10 | 28.00 |
| 6 | | P344A16 | K5TB1-5 | 10 | K4-C3 | 10 | 7.00 |
| 7 | | P344B16 | K4-C3 | 10 | K3-C3 | 10 | 5.00 |
| 8 | | P344C16 | K3-C3 | 10 | K2-C3 | 10 | 8.00 |
| 9 | | P344D16 | K2-C3 | 10 | K1-C3 | 10 | 9.00 |
| 10 | | P344E16 | K1-C3 | 10 | A1TB1-4 | 10 | 3.00 |
| 11 | | P344F16 | A1TB1-4 | 10 | DS1-1 | — | 24.00 |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | P345A16 | S1-15 | 10 | K1-C1 | 10 | 19.00 |
| 16 | | P346A16 | S1-25 | 10 | K2-C1 | 10 | 24.00 |
| 17 | | P347A16 | S1-35 | 10 | K3-C1 | 10 | 29.00 |
| 18 | | P348A16 | S1-45 | 10 | K4-C1 | 10 | 34.00 |
| 19 | | P345B16 | K1-C1 | 10 | DS1-2 | — | 21.00 |
| 20 | | P349A16 | A1TB1-1 | 10 | DS1-3 | — | 25.00 |
| 21 | | P349B16 | S2-2 | 10 | A1TB1-1 | 10 | 24.00 |
| 22 | | X350A16 | T1-5 | 9 | A1TB1-2 | 10 | 14.00 |
| 23 | | X351A16 | T1-6 | 9 | A1TB1-3 | 10 | 14.00 |
| 24 | | X352A12 | L0 | 18 | A2-22 | 4 | 10.00 |
| 25 | | X353A16 | T1-1 | 9 | A2-78 | 11 | 16.00 |
| 26 | | X354A16 | T1-4 | 9 | A2-77 | 11 | 16.00 |
| 27 | | X355A16 | T1-3 | 9 | A2-73 | 11 | 19.00 |
| 28 | | | | | | | |
| 29 | | X357F16 | A2-76 | 11 | L2 | 7 | 12.00 |
| 30 | | X355B16 | A2-73 | 11 | L1 | 7 | 12.00 |
| 31 | | X355C6 | L1 | 6 | K1-L1 | 8 | 31.00 |
| 32 | | X355D6 | L1 | 6 | K2-L1 | 8 | 24.50 |
| 33 | BLACK | X355E6 | L1 | 6 | K3-L1 | 8 | 20.00 |

| WIRE NO. | WIRE MARKING IDENTIFICATION | | FROM | TERMN FIND NO. | TO | TERMN FIND NO. | LG REF |
|---|---|---|---|---|---|---|---|
| | COLOR | NUMBER | | | | | |
| 34 | BLACK | X355F6 | L1 | 6 | K4-L1 | 8 | 19.00 |
| 35 | | X357A6 | L2 | 6 | K1-L2 | 8 | 28.50 |
| 36 | | X357B6 | L2 | 6 | K2-L2 | 8 | 23.00 |
| 37 | | X357C6 | L2 | 6 | K3-L2 | 8 | 18.00 |
| 38 | | X357D6 | L2 | 6 | K4-L2 | 8 | 18.00 |
| 39 | | X358A6 | L3 | 6 | K1-L3 | 8 | 27.00 |
| 40 | | X358B6 | L3 | 6 | K2-L3 | 8 | 21.50 |
| 41 | | X358C6 | L3 | 6 | K3-L3 | 8 | 19.00 |
| 42 | | X358D6 | L3 | 6 | K4-L3 | 8 | 20.00 |
| 43 | | X352C12 | A2-46 | 4 | A2-70 | 4 | 4.00 |
| 44 | | X352D12 | A2-22 | 4 | A2-16 | 4 | 3.00 |
| 45 | | X352E12 | A2-16 | 4 | A2-40 | 4 | 5.00 |
| 46 | | X352F12 | A2-40 | 4 | A2-64 | 4 | 5.50 |
| 47 | BLACK | X352H12 | A2-16 | 4 | A2-10 | 4 | 3.00 |
| 48 | BLACK | X352J12 | A2-10 | 4 | A2-34 | 4 | 6.00 |
| 49 | | X352K12 | A2-34 | 4 | A2-58 | 4 | 6.00 |
| 50 | | X352L12 | A2-10 | 4 | A2-4 | 4 | 3.00 |
| 51 | | X352M12 | A2-4 | 4 | A2-28 | 4 | 5.50 |
| 52 | | X352N12 | A2-28 | 4 | A2-52 | 4 | 6.00 |
| 53 | | X352B12 | A2-22 | 4 | A2-46 | 4 | 4.00 |
| 54 | | X359A6 | K1-T1 | 8 | A2-1 | 5 | 25.00 |
| 55 | | X360A6 | K1-T2 | 8 | A2-25 | 5 | 25.00 |
| 56 | | X361A6 | K1-T3 | 8 | A2-49 | 5 | 25.00 |
| 57 | | X362A6 | K2-T1 | 8 | A2-7 | 5 | 20.00 |
| 58 | | X363A6 | K2-T2 | 8 | A2-31 | 5 | 20.00 |
| 59 | | X364A6 | K2-T3 | 8 | A2-55 | 5 | 20.00 |
| 60 | | X365A6 | K3-T1 | 8 | A2-13 | 5 | 19.00 |
| 61 | | X366A6 | K3-T2 | 8 | A2-37 | 5 | 16.00 |
| 62 | | X367A6 | K3-T3 | 8 | A2-61 | 5 | 18.00 |
| 63 | | X368A6 | K4-T1 | 8 | A2-19 | 5 | 17.00 |
| 64 | | X369A6 | K4-T2 | 8 | A2-43 | 5 | 15.00 |
| 65 | BLACK | X370A6 | K4-T3 | 8 | A2-67 | 5 | 19.00 |
| 66 | BLACK | X357E16 | A2-76 | 11 | T1-2 | 9 | 16.00 |

Figure 13-7. Dummy load kit control box harness (sheet 2 of 3)

| FIND NO | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 18 | | | MS25036-155 | 1 | TERMINAL, LUG, CRIMP STYLE | | |
| 17 | | | SN60WRAP2 | AR | SOLDER, LEAD TIN ALLOY, ROSIN CORE | QQ-S-571 | NOTE 2 |
| 16 | | | MS3102R10SL-3P | 1 | CONNECTOR, RECEPTACLE | | |
| 15 | | | TYPE F, FORM Ua<br>GRADE A CL1<br>CATEGORY 1 | 2 | TUBING, INSULATION<br>.106 I.D. X .016 WALL X .62 LG | MIL-I-631 | |
| 14 | | | MS3367-4-9 | 59 | STRAP, TIEDOWN | | NYLON |
| 13 | | | MS3367-1-9 | 12 | STRAP, TIEDOWN | | NYLON |
| 12 | | | MS39020-1 | 1 | BAND, MARKER | | AL ALY |
| 11 | | | MS25036-109 | 6 | TERMINAL, LUG, CRIMP STYLE | | |
| 10 | | | MS25036-106 | 33 | TERMINAL, LUG, CRIMP STYLE | | |
| 9 | | | MS25036-153 | 6 | TERMINAL, LUG, CRIMP STYLE | | |
| 8 | | | MS25036-120 | 24 | TERMINAL, LUG, CRIMP STYLE | | |
| 7 | | | MS25036-155 | 2 | TERMINAL, LUG, CRIMP STYLE | | |
| 6 | | B | 71-4906-03 | 12 | TERMINAL, LUG, CRIMP STYLE | | |
| 5 | | | MS25036-121 | 12 | TERMINAL, LUG, CRIMP STYLE | | |
| 4 | | | MS25036-113 | 23 | TERMINAL, LUG, CRIMP STYLE | | |
| 3 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| 2 | | | M5086/2-12-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |
| 1 | | | M5086/2-6-9 | AR | WIRE, ELECTRICAL | MIL-W-5086/2 | |

LIST OF MATERIAL

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 17.
3. CABLE STRAPS, FIND NO. 13 AND 14, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

| WIRE LENGTH TOLERANCES | | |
|---|---|---|
| OVER | INCL. | TOL. ± |
| 0 | .50 | .12 |
| .50 | 2 | .19 |
| 2 | 6 | .25 |
| 6 | 12 | .30 |
| 12 | 36 | .50 |
| 36 | 100 | 1 |
| 100 | 200 | 1.50 |
| 200 | UP | 2 |

Figure 13-7. Dummy load kit control box harness (sheet 3 of 3)

to cathode (-), value should be low. Reverse meter leads, value should be infinity.

d. Test load dumping relay K5 as specified in paragraph 13-13.

e. Inspect parts for cracks, breaks, distortion and dents.

f. Inspect threads for damage.

13-26. REPAIR.

a. Repair cracked metal parts by welding.

b. Straighten damaged or distorted sheet metal parts using suitable tools.

c. Repair wiring harness as specified in figure 13-7.

13-27. WIRING HARNESS REBUILD. Rebuild dummy load kit control box harness as specified in figure 13-7.

13-28. REASSEMBLY. Refer to figure 13-5 and reassemble control box assembly in the reverse order of index numbers assigned. Pay particular attention to the following.

a. Reassemble load dumping relay (45) as specified in paragraph 13-18.

b. When installing links (97), set links for desired voltage output, refer to Operator and Organizational Maintenance Manual.

NOTE

Dummy load kit wiring diagram is contained in Operator and Organizational Maintenance Manual

c. Prior to installing cover (11) check harness (51) wires and rear links (82) for proper connection.

d. Coat all solder connections with fungus resistant varnish conforming to Military Specification MIL-U-173B prior to installing cover (11).

13-29. INSTALLATION. Refer to figure 13-1 and install control box as follows.

NOTE

Control box cover must be removed prior to installation.

a. Position panel (67), firewall (66), and control box (68) on frame (67) and secure with screws (63) and washers (64 and 65).

NOTE

Dummy load bank wiring diagram is contained in Operator and Organizational Maintenance Manual.

b. Connect frame harness wires to control box components. Check wires for proper connection.

c. Install cover (62) and secure switch screws (60) and washers (61).

# APPENDIX A

## REFERENCES

### A-1. FIRE PROTECTION.

| | |
|---|---|
| TB 5-4200-200-10 | Hand Portable Fire Extinguisher Approved for Army Users |

### A-2. LUBRICATION.

| | |
|---|---|
| C91001L | Fuels, Lubricants, Oils and Waxes |
| LO5-6115-458-12 | End Item Lubrication Order |

### A-3. PAINTING.

| | |
|---|---|
| T.O. 35-1-3 | Painting and Marking of USAF Aerospace Ground Equipment |
| TM 9-213 | Painting Instructions for Field Use |

### A-4. RADIO SUPPRESSION.

| | |
|---|---|
| MIL-STD-461 | Radio Interference Suppression |
| TM 11-483 | Radio Interference Suppression |

### A-5. MAINTENANCE.

| | |
|---|---|
| T.O. 00-25-225 | Repair of External Power Cables, Aerospace Ground Equipment |
| T.O. 00-25-234 | General Shop Practice Requirements for the Repair, Maintenance and Test of Electronic Equipment |
| T.O. 1-1-1 | Cleaning of Aerospace Equipment |
| T.O. 1-1A-14 | Installation Practices for Aircraft Electric and Electronic Wiring |
| T.O. 31-1-75 | General Maintenance Practices |
| T.O. 35-1-11 | Organization, Intermediate and Depot Level Maintenance for FSC 6115 Non-Airborne Equipment |
| T.O. 35-1-12 | Compounds and Procedures for Cleaning Aerospace Ground Equipment |

| | |
|---|---|
| T.O. 35-1-26 | Repair/Replacement Criteria for FSC 6115 Aerospace Ground Equipment |
| T.O. 35-1-524 | USAF Equipment Registration Number System Applicable to FSC 6115 Equipment |
| TM 9-1870-1 | Care and Maintenance of Pneumatic Tires |
| TB 750-651 | Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems |
| TM 38-750 | The Army Maintenance Management System |
| TM 5-6115-458-12 | Operator and Organizational Maintenance Manual |
| TM 5-6115-458-35 | Intermediate (Field) (Direct and General Support) and Depot Maintenance Manual |
| TM 5-6115-458-24P | Organizational, Intermediate (Field) (Direct Support and General Support) and Depot Maintenance Repair Parts and Special Tools Lists |
| TM 9-2920-232-34 | Starter Motor Field Maintenance Manual |
| TM 9-6140-200-15 | Operation and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type |
| TM 5-764 | Electric Motor and Generator Repair |
| MIL-HDBK-705 | Military Standardization Handbook, Generator Sets, Electrical Measurements and Instruments |
| MIL-I-6868 | Inspection Process, Magnetic Particle |
| MIL-I-25135 | Inspection Materials, Penetrant |
| MIL-STD-120 | Gauge Inspection |
| MIL-STD-454 | Standard General Requirements for Electronic Equipment |
| MIL-STD-705 | Generator Sets, Engine-Driven Methods of Test and Instructions |
| MIL-STD-1261(MR) | Welding Procedures for Construction Steels |
| MIL-T-27730 | Tape, Antiseize, Polytetrafluoroethylene, with Dispenser |

| | |
|---|---|
| MS 33540 | Safety Wiring and Cotter Pinning, General Practices for |

## A-6. SHIPMENT AND STORAGE.

| | |
|---|---|
| T.O. 35-1-4 | Processing and Inspection of Aerospace Ground Equipment for Storage and Shipment |
| T.O. 38-1-5 | Processing and Inspection of Non-Mounted, Non-Aircraft Gasoline and Diesel Engines for Storage and Shipment |
| TB 740-90-1 | Administrative Storage of Equipment |
| TB 740-93-2 | Preservation of USAMEC Mechanical Equipment for Shipment and Storage |
| TM 38-230 | Preservation, Packaging and Packing of Military Supplies and Equipment |
| MIL-S-207 | Sulfuric Acid, Electrolyte: Packaging, Packing, and Marking for Shipment and Storage of |

## A-7. DESTRUCTION OF MATERIEL.

| | |
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| TM 750-244-3 | Procedures for Destruction of Equipment to Prevent Enemy Use |

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